NAWAC
National Animal Welfare Advisory Committee

NAWAC OPINION

on animal welfare issues associated with selective breeding

New Zealand Government

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Foreword

Man's association with animals is long-standing and our interactions varied, as animals have provided us with wide-ranging services including as companions and as producers of food and clothing. Very early in our association, we discovered we could use selective breeding to change animals' behaviour, appearance, or productivity, and the genetics of our modern animals have been refined in many ways.

There are many examples where selective breeding practices have produced positive welfare outcomes, e.g. selecting animals for disease resistance; however, there are also many examples where welfare outcomes are poor, whether because of breeding a companion animal to support an owner's vanity, or a production animal whose physiological capacity cannot support its genetically-dictated production.

The National Animal Welfare Advisory Committee (NAWAC) has recently examined the use of selective breeding practices in New Zealand, and considered their impact on animal welfare. This paper documents a wide range of examples which were of concern because of evidence of their potential to reduce the welfare of the animals concerned.

At the time of its publication, this paper represents the collective opinion of NAWAC. It has been published because selective breeding was one of several issues identified by NAWAC for which, in order to fulfil its advisory function, development and documentation of a formal Committee position was needed.

I acknowledge the work of NAWAC members, past and present, who developed this paper, and the chairmanship of Dr John Hellström, under whose watch the NAWAC work programme was developed. I also acknowledge the extensive assistance provided by the secretariat at the Ministry for Primary Industries during the document's development and drafting.

Dr Gwyneth Verkerk
NAWAC Chair

Introduction

There are many illustrations of the spectacular success of selective breeding. As an example, through selection alongside improvements in health, nutrition and stockmanship, the average number of eggs a hen laid per year in New Zealand rose from 130 in 1975 to 312 in 2008, while lambs weaned per 100 ewes per year rose from 100 in 1991 to 124 in 2003. Selective breeding, alongside management changes, can have a role in addressing long-standing, routine and serious welfare issues, including mortality, aggression, and resistance to disease (Turner et al 2015). With respect to companion animals, selective breeding has given us the wide range of dog breeds available, from the tiny Chihuahua to the Great Dane.

However, there have also been negative effects. Selecting for inherited traits that are seen as desirable, whether that be for increased production, efficiency of feed conversion or the way an animal looks, may result in unintended or undesirable consequences. An example might be the negative genetic correlation between high milk production and various fertility traits in the dairy cow (Rauw 1998). Or it may be due to significant structural changes that have been bred in over time and that interfere with normal functioning. An example would be congenital obstructive upper airway disease (brachycephalic obstructive airway syndrome) found in some brachycephalic breeds of dog.

There can also be negative effects from breeding for particular behavioural traits. While such breeding can potentially be beneficial, ethical concerns have been raised around unintentional consequences of selecting for behaviour. Breeding for changes in behaviour risks compromising the nature, or 'telos', of a species. For example, selecting for docility could create 'stoics' who appear on the outside to be less reactive to situations they would normally find aversive, but in fact still experience negative feelings internally (D'Eath et al 2010).

Good animal welfare requires a satisfactory match between genetics and the environment (Fraser et al 2013), so it is important to remember that selection in one environment may mean that animals do not perform well in other environments. For example, a high producing dairy cow may do well in an intensive indoor environment, but suffer from poor welfare if raised in a low input pastoral system.

There are also consequences that arise from the euthanasia of healthy animals that are surplus to requirements for a variety of reasons: they may be of the wrong sex; they may, from a production point of view, simply be a means to an end rather than the end itself; they may be the wrong colour; or not fast enough. They may be the result of indiscriminate or uncontrolled breeding.

New Zealand's legislation requires that owners and persons in charge of animals must take all reasonable steps to ensure that the physical, health and behavioural needs are met in accordance with good practice and scientific knowledge. It is the opinion of the National Animal Welfare Advisory Committee (NAWAC) that it is indeed a reasonable step to take into account the potential for adverse animal welfare outcomes when animals are bred, whether that be for specific traits or for any other reason.

This paper will:

- Summarise the process NAWAC has used in coming to its opinion;
- Summarise New Zealand legislation and guidelines relevant to breeding issues, and look at how some overseas jurisdictions deal with such issues;
- Give an overview of gene marker assisted selection;
- Provide more detailed appraisal of breeding issues and practices on a species by species basis, drawing on the literature and including code of welfare recommendations and industry or organisation comments. NAWAC's views for each species will be given;
- Provide NAWAC's summary including conclusions and recommendations.

The paper is split into two parts: Production animals and non-production animals. This is to reflect that the drivers for, and implications of, selective breeding for performance traits in livestock are very different to the drivers for companion animals,

racing animals or animals in zoos, aquariums and wildlife parks. Specific breeding goals vary by industry, species or even area, and responsible breeders already include health and welfare traits. Ultimately, however, livestock breeding has a focus on increasing production; meanwhile companion animal breeding places a focus on appearance and temperament, racing animal breeding on speed, and zoo/sanctuary animal breeding on increasing vulnerable populations.

For each species, differing amounts of information are presented. This reflects these different drivers for animal selection, the amount of research available, and the fact that in most cases, formal measures (to differing levels) have already been put in place to address welfare concerns.

NAWAC's process

NAWAC reviewed relevant literature and undertook a series of consultation meetings with stakeholders, seeking to identify both positive and negative welfare effects associated with breeding. More specifically, the following questions were asked:

1. What does your organisation see as an ethical approach to selective breeding?
2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?
3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?
4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?
5. What does your organisation see as the key drivers for the future in terms of selective breeding?
6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

NAWAC was also interested in how the different groups were managing breeding so as to mitigate the need for euthanasia of healthy animals.

NAWAC met with the following stakeholders:

- New Zealand Veterinary Association (NZVA), who also gave a written submission;
- New Zealand Thoroughbred Racing (NZTR);
- New Zealand Greyhound Racing Association (NZGRA), who also gave a written submission;
- NZ Pork;
- New Zealand Kennel Club (NZKC), who also gave a written submission and shared a breeders code of ethics, also some contact with Australian National Kennel Council (ANKC);
- New Zealand Beef + Lamb, who also gave a written submission;
- DairyNZ, who also gave a written submission;
- Academics from the Animal Welfare Science and Bioethics Centre (AWSBC), Massey University.

The following organisations provided written submissions:

- Royal New Zealand SPCA;
- Aquaculture NZ;
- Aviagen (international meat chicken breeding company);
- Cobb (international meat chicken breeding company);
- Hy-Line (international layer hen breeding company);
- ISA (international layer hen breeding company, part of Hendrix Genetics);
- Federated Farmers (re: dairy goats);
- New Zealand Cat Fancy.

Initial written submissions are included in Appendix One.

Once the preliminary information was gathered and a draft written, NAWAC invited and reviewed submissions to ensure that this paper reflects the New Zealand context and the considerable work that the different industries are already putting into addressing animal welfare concerns related to the breeding of animals. During this second round of consultation NAWAC also received comment from the Zoo and Aquarium Association, the Egg Producers Federation, the Poultry Industry Association of New Zealand, Caprinex, the Advocateship of Purebred Dog Breeders, and the Federation of New Zealand Aquatic Societies.

The opinion paper has been peer reviewed by Dr Joanne Conington (University of Edinburgh).

NAWAC is grateful to all those who contributed.

Legislation and guidelines

The only specific reference to animal breeding within the Animal Welfare Act 1999 relates to research, testing and teaching (RTT). For the purposes of RTT, using breeding technologies that will result in animals with characteristics making them susceptible to increased pain and suffering during their life now falls within the definition of a manipulation and will require full animal ethics committee approval. Another committee, the National Animal Ethics Advisory Committee (NAEAC), advises the Minister for Primary Industries on these matters[1]. In a general sense, ensuring physical, health and behavioural needs could be seen to cover selective breeding for all other animals. Issues of breeding, and selection for breeding, are inconsistently raised in codes of welfare (see individual species for detail).

Other jurisdictions

- The Australian state of Victoria's Department of Primary Industries has a Code of Practice for the Responsible Breeding of Animals with Heritable Defects that cause Disease, with a legislative basis.
- EU law on animal breeding procedures is contained in EU Directive 98/58/EC. Its Annex states:
  "Natural or artificial breeding or breeding procedures which cause or are likely to cause suffering or injury to any of the animals concerned must not be practised."
  "No animal shall be kept for farming purposes unless it can reasonably be expected, on the basis of its genotype or phenotype, that it can be kept without detrimental effect on its health or welfare."
- International breeding organisations such as the European Forum of Farm Animal Breeders (EFFAB[2]) set ethical guidelines for breeding production animals that include genetic diversity, sustainability and animal health and welfare within their remit.
- The Farm Animal Welfare Council (FAWC), who advise the Department for Environment, Food and Rural Affairs in the UK (Defra), released an overview of the animal welfare implications of breeding strategies and breeding technologies in 2012 (FAWC, 2012).
- In 2017, FAWC released Advice on sustainable agriculture and farm animal welfare which included discussion of animal breeding.
- Reports from the May 2015 and 2016 meetings of EuroFAWC include the following activities from European countries:
  - Norway – The Council on Animal Ethics has released two short opinions about ethical aspects of sheep breeding (increased number of lambs per ewe) and the destruction of "surplus" animals just after birth (male goat kids and chicks).
  - Austria – The Animal Welfare Council is discussing "extreme breeding" which they describe as "torture breeding". "Breeders are to be obliged to disclose their respective breeding programmes when reporting to the authority, thus making it easier for the authority to verify that breeding programmes avoid torture breeding".
  - Belgium – In 2015, the Animal Welfare Council started examining the issue of disorders in dogs as a result of excessive breeding for physical appearance by producing an information report outlining the problem as well as the structure and activities of the canine world. The AWC also drew up an opinion with science-based recommendations. In 2016, the council of Wallonia issued an opinion on the overpopulation of cats and the need for general sterilisation.
  - Finland – The Pet and Hobby Animals Welfare Council has stated that "animal breeding that lowers animal welfare and health have to end".
  - Ireland – The Farm Animal Welfare Advisory Council (FAWAC) has dealt with concerns around the continuing indiscriminate breeding of horses without any consideration for market outlets.

1 http://www.mpi.govt.nz/protection-and-response/animal-welfare/overview/national-animal-ethics-advisory-committee/
2 http://www.effab.info/

Gene marker assisted selection

The potential to more rapidly detect genetic markers with deleterious effect is perhaps most easily exploited in commercially farmed animals, and particularly in those species that have large numbers of offspring such as pigs, chickens and particularly fish. There are also large international companies associated with breeding these species. Some of the counter-productive genes will be genetic disorders, and there is thus an economic stimulus to reduce their incidence.

A breed specific gene test for selecting polled cattle has been developed by the CSIRO in Australia and is now commercially available through Zoetis. This allows the separation of animals carrying polled genes from carriers of horn or scur genes, in a complicated system of inheritance largely in Bos indicus cattle (Prayaga, 2007). The HornPollTM test is only suitable for the Brahman, Santa Gertrudis, Droughtmaster, Hereford and Simmental breeds, and any crosses of these breeds at this stage. Research continues in the application of this test in other breeds. The test was developed to reduce the cost of dehorning animals, the loss of meat to bruising and down grading of hides by scratches from horns. However, in reducing the incidence of horns it brings welfare benefits.

The same is true for the sex-linked gene for horns in Merino sheep where, but the test is not transferable to other breeds. For example the genes that cause horns in the Dorset Horn and Wiltshire Horn cause horns in both sexes and are controlled by a different gene. In the future, given economic viability, tests for such traits may become available across a wider range of sheep breeds. However, breeding polled goats has been plagued by an association with infertility, through an intersex phenotype. With gene testing, there is the potential to find poll genes that do not associate with infertility in goats.

Not all genes for welfare traits will need a gene test, and costly development and use of tests should be examined. The horned genotypes of the Drysdale and Tukidale sheep carry a single dominant gene associated with their fleece type and could easily be replaced by the polled Elliotdale without a gene test. These are now largely rare breeds kept by those with a fascination for their appearance including the horns! On the other hand, short tails in sheep are strongly inherited (approx. 70% heritable) visible at birth, and likely to involve a number of genes (Scobie and O'Connell, 2007). Moving to a short tailed population requires only the presence of the genes for short tail in the population and either the economic stimulus or the will to select for this trait and not a gene test.

Whereas livestock are largely farmed for profit, when we consider inherited genetic disorders in non-livestock species, different criteria arise. The economic stimulus is often at odds with welfare goals. A perverse example is the Scottish Fold cat which is currently a financially valuable genotype because of its phenotype. Ironically, a gene test to improve the likelihood of producing offspring with this cartilage disorder might be financially viable! Demand for the gene(s) is the problem and public opinion must first move away from the phenotype. It is important to understand why breeding persists in these cases, and why consumers persist in acquiring these animals.

However, cats and dogs can produce a number of offspring like pigs and chickens, and since their parentage is often very well recorded it is thus easy to uncover genes. The Humane Society Veterinary Medical Society has published a list of 334 congenital and genetically transmitted diseases for dogs alone[3]. A number of gene markers for debilitating genetic deformities are available for both these species. Gribbles Veterinary and New Zealand Veterinary Pathology (NZVP) offer gene testing in New Zealand for dogs and cats and although some of these tests are for coat colour or hair length, many are for traits like Polycystic Kidney Disease (PKD) Testing, Progressive Retinal Atrophy (PRA) or Spinal Muscular Atrophy (SMA).

Gene marker assisted selection for traits such as polledness is just one tool that could be of use in the future. At this time, the scope for animal welfare outcomes, whether positive or negative, is unknown for other genetic technologies such as genetic modification or cloning. Such tools present an interesting option for the future and their impact on animal welfare will need to be considered carefully.

3 http://www.hsvma.org/assets/pdfs/guide-to-congenital-and-heritable-disorders.pdf.

Production Animals

Dairy cattle

Code of welfare

The code of welfare for dairy cattle has a section on selection of animals for mating (5.12), but this relates age, size and condition rather than genetic selection.

Industry's view

DairyNZ sees as an ethical approach to selective breeding as focusing on animals that are "fit for purpose" – i.e. animals that are profitable, well adapted to New Zealand farming conditions and productive without having negative health impacts. This means taking account of not only productive capacity when selecting animals to breed from, but also directly traits such as fertility, somatic cell score and residual survival, which includes traits other than production such as temperament, udder quality, and resistance to lameness and mastitis. Focusing only on production as a trait did lead to a reduction in cow fertility in the past when a lot of Holstein type genetics were introduced during the '90s. The industry is now very aware that a multi-trait, balanced selection process produces animals that are better overall for the farming system.

DairyNZ also finds it important that all animals that are bred in the farming system have a use. It is claimed that there is very little slaughter, and disposal with no return, of animals in the dairy industry, with the number of bobby calves killed on farm estimated at less than 0.5 percent of the total.

DairyNZ, through its subsidiary NZ Animal Evaluation Limited, is responsible for setting the National Breeding Objective (NBO) for dairy cattle. The NBO is expressed via Breeding Worth ($ net farm income per 5 tonne of dry matter) which includes seven traits (milk volume, milk protein, milk fat, fertility, somatic cell score, liveweight and residual survival) known to influence the profitability of dairy cattle. The use of the Breeding Worth index has resulted in dairy cattle that are more productive and live longer - on average, cows are staying the herd for 207 days more now that they were in 1984 (LIC via Nita Harding, Dairy NZ pers comm.). The 2002 introduction of fertility into Breeding Worth has helped – along with an improvement in bull fertility – arrest a decline in fertility in the national herd.

In terms of mitigating any negative effects of selective breeding, the dairy industry uses a balanced selection index that includes not only production factors, but also aspects of animal health and welfare, to ensure that "fit for purpose" animals are being bred for the industry. For example, the addition of body condition score as a trait for Breeding Worth has been approved and this will start from February 2016. DairyNZ also provides results of gene tests for individual bulls, such as small calf syndrome, so these genetic variants can be considered in mating. In addition, a research project is being undertaken, with a range of industry partners, to identify the reasons for the early exit of young stock and dairy cattle from dairy herds so that more targeted genetic and management solutions can be provided for the industry.

In breeding is monitored and actively managed during mating via the use of alerts that warn of father daughter matings when cow numbers are entered into data base by the AI technician before insemination. An alternative bull can then be used instead of the bull rostered on for that days use.

Useful technology is seen as including:

- Genomics, in enabling the identification of genetic variants that can have negative effects on animal health and welfare. This is widely used within the industry.
- More comprehensive and accurate phenotypic recording, also enabling better identification of the genetics underlying animal health and welfare traits. Deep phenotyping (the precise and comprehensive analysis of phenotypic abnormalities in which the individual components of the phenotype are observed and described) has become more commonplace over recent years to enable this matching of genetics and phenotype to occur.

The industry also notes emerging technology that has the potential to allow estimation of breeding values for lameness, mastitis and facial eczema tolerance. The possibility of genetically improving dairy cattle for these traits is being explored.

Key drivers for the future include the desire to reduce culling rates in the industry, thus improving cow longevity. To do this, cows need to produce well, have reduced susceptibility to common diseases such as mastitis and lameness, and be fertile. AN MBIE-funded project is underway on lifetime productivity that DairyNZ, AgResearch and others are working collaboratively on. This is a multi-million dollar project due to run for 7 years. The project has only been underway since late 2014 so there are no results as such so far.

NAWAC's view

- The committee has concerns that, despite the ability to select for polledness, this is not a priority due "the compromises in genetic gain elsewhere that would occur if there was more of a focus on polled genetics". Given the welfare impacts, as well as the financial costs, of disbudding and dehorning, we would want convincing that the potential compromises outweigh what we would see as a means to significantly improve animal welfare. The committee supports efforts by companies (such as CRV Ambreed[4]) who are working to have high indexing polled genetics available.
- The link between use of indoor systems and higher production could have implications for cow longevity. The strengthening of traits such as udder conformation, particularly in relation to the suspensory ligament, as well feet, legs and somatic cell counts should be considered for higher weighting under animal evaluation.
- As varied environments are introduced (for example, indoor housing) it should continue to be emphasised that animal genotype is appropriate for its environment. A very high producing cow may do well in an intensive indoor environment, but suffer from poor welfare (for example, a lower body condition score) if raised in a low input pastoral system.
- The use of early calve/easy calve bulls may lead to smaller animals being born and possibly more on farm euthanasia of the smaller calves if they take longer to be big enough for processing or are undesirable for onward rearing. Their benefit is however tied directly into reducing gestation length and these bulls are a useful tool now that there is no induction option as a general farming practice.
- More emphasis is being put on the use of beef bulls as they are being pushed as an option to increase saleability of surplus calves. Some of this cross breeding can lead to problems at calving if the wrong bull has been selected, or if the cows are not of an age to handle having a bigger calf. Care should be taken to ensure that easy calve bulls are used when they are to be crossed with dairy animals, especially over maiden heifers.
- The NZVA warned of the potential negative outcomes through extensive use of popular sires of selection. A recent example was the birth of around 1500 calves in 2012 which were particularly hairy, all sired by a genetic mutation from a single bull.

Apart from the above concerns, the selective breeding approach the dairy industry is following is appropriate for the welfare of the cows, and the industries needs at present.

Overbreeding

Dairy cattle must be pregnant to produce milk, and excess calves, usually male, are often euthanised. Sexed semen would reduce the need to euthanise male calves (although would presumably result in an excess of female calves), and so NAWAC encourages such technology if it can be used alongside changes in animal management and selection to result in fewer calves being born to be euthanised shortly afterwards. NAWAC supports DairyNZ's focus on all animals having a use, for example having excess dairy calves raised for beef.

4 https://www.crv4all.co.nz/genetics-catalogue/breeding-programme-gives-birth-to-horn-less-dairy-cows/

Goats

Code of welfare

The code of welfare for goats makes two references to selection for breeding as a Recommended Best Practice:

- Easy-kidding sires should be selected for goatling[5] mating as large kids can cause significant injuries to small does.
- When selecting goats for breeding, attention should be given to selecting animals of appropriate physical size (both buck and doe), kidding experience and previous management history to match the system in which they will be farmed (i.e. previously kept extensively or intensively).

Industry's view

One of the main welfare issues for goats is disbudding, both in terms of provision of pain relief and because of the thinness of the skull, compared to calves – issues that are being looked at by AgResearch. Breeding for polledness is not seen as a solution because "polled goats are much less fertile".

Male offspring in the dairy goat industry are surplus to requirements unless they can be reared for meat, a move that is encouraged by the industry, which has a policy of developing markets to utilise the surplus males. In addition there has been some shift to year around milking with the aim of reducing the pregnancy rate and therefore the number of kids.

5 A female before completion of the first lactation. The term goatling is more commonly used in the dairy goat industry while the terms hogget and yearling is more commonly used in the fibre and meat goat industry.

NAWAC's view

- While the genetic link between polledness and intersex has been demonstrated in a number of papers (Pailhoux 2001, Vaiman 1996), NAWAC is aware of the speed with which genetic research is advancing and would like to see further exploration of this issue, with an ultimate aim of reducing the need to disbud.
- NAWAC would encourage research into how breeding could be used to reduce resistance into such issues as susceptibility to internal parasites, flystrike (mainly Angoras), lameness and udder conformation.

Overbreeding

The use of sexed semen would reduce the need to euthanase excess male goat kids, unless or until a goat meat industry is well enough established to cope with all kids not needed in the dairy industry.

Sheep

Code of welfare

The code of welfare for sheep and beef cattle has a comprehensive section (7.1) on breeding and selection, with a series of seven Recommended Best Practices:

- (a) Selection practice should not include selection for increased productivity (e.g. increasing growth rate, fecundity) if it is known or thought to unreasonably compromise animal health or welfare.
- (b) Selection policies resulting in significant routine compromises to animal welfare (e.g. increased need for caesarean sections) should be avoided.
- (c) The animal welfare impacts of animal selection and breeding objectives should be monitored for favourable and unfavourable consequences, and the results incorporated into future objectives.
- (d) Selection for resistance to diseases should complement but not replace other means of ensuring animals are healthy (e.g. providing good nutrition to enable animals to mount good immune responses to pathogens).
- (e) To minimise the risk of dystocia and other health problems, the selection of sires for breeding (either natural or by artificial insemination) should take into account factors such as the dam's breed, size, age, and the sire's birthweight and birthing ease genetics, and the likely size of the offspring relative to the dam. This is especially important when hoggets or yearling heifers are mated before they have reached mature live weights.
- (f) Hoggets and heifers selected to be mated should be well grown, fed to allow for continued growth as well as pregnancy and carefully supervised around the time they give birth.
- (g) Animals, particularly males that are likely to lose condition during mating, should be healthy and in good condition (i.e. condition score 3 or more[6]) at the start of the breeding season.

6 On a scale of 1 to 5.

Industry's view

Beef & Lamb New Zealand Genetics (B+LNZ Genetics) is a subsidiary of industry good organisation Beef & Lamb New Zealand (B+LNZ). They see an ethical approach to breeding as focusing on producing productive but resilient animals that handle the natural variation in feed supply and climate while producing high quality products in the range of farm environments found in New Zealand.

Improved longevity, lamb survival, and ewe body condition score are key to such resilience. In addition, control of inbreeding, which in the past led to the build-up of deleterious recessive genes and inherited diseases, emphasises the need to maintain genetic diversity.

Selective breeding has brought significant improvements in animal health in the sheep industry, with selection for resistance to the facial eczema toxin and internal parasites. Identification of and selection away from deleterious individual genes has also been possible. An example is the condition Microphthalmia found primarily within the Texel breed and crosses made out of that breed, and results in blindness due to extremely small or absent eyes.

Whereas in the past, increased fecundity led to lower lamb survival, the industry states that farmers can now select for improved lamb survival, setting a maximum reproductive rate they believe to be sustainable for their farming system. There has been considerable selection for increased growth rates and carcass leanness in sheep.

On the other side of that, there is anecdotal evidence that the selection for leanness in slaughter animals has produced breeding ewes that have lower fat reserves, which can impact negatively during times when feed supply is restricted. Work is underway investigating increasing fatness in lamb carcasses to improve eating quality. B+LNZ Genetics sees that many of the negative effects of selective breeding have come from taking a narrow view of performance based on very few traits, and is undertaking research

to develop suitable indexes for a range of farming environments. These indexes take a wide view of animal performance including growth, reproduction, health and disease traits.

B+LNZ Genetics makes extensive use of technology to deal with breeding issues. These DNA technologies will enable the measurement of genetic merit without the need to, for example, challenge individuals with a disease to measure their resistance to it. They also plan a genetic evaluation system that is able to analyse both DNA and phenotypic data at the same time. This 'single-step' system will ensure that as much information as possible is included in any genetic analysis, meaning the likelihood of unfavourable outcomes is reduced.

A core part of the B+LNZ Genetics programme is the Central Progeny Test. This is a national evaluation of industry rams. Animal performance is measured in a range of environments to ensure that rams that rank well on one type of country do not have poor performance on another type.

NAWAC's view

NAWAC is satisfied that the sheep industry's approach to selective breeding, focused as it is on the resilience of these animals in a variety of environments, is appropriate.

Beef cattle

Code of welfare

The code of welfare for sheep and beef cattle has a comprehensive section (7.1) on breeding and selection, with a series of seven Recommended Best Practices:

- (a) Selection practice should not include selection for increased productivity (e.g. increasing growth rate, fecundity) if it is known or thought to unreasonably compromise animal health or welfare.
- (b) Selection policies resulting in significant routine compromises to animal welfare (e.g. increased need for caesarean sections) should be avoided.
- (c) The animal welfare impacts of animal selection and breeding objectives should be monitored for favourable and unfavourable consequences, and the results incorporated into future objectives.
- (d) Selection for resistance to diseases should complement but not replace other means of ensuring animals are healthy (e.g. providing good nutrition to enable animals to mount good immune responses to pathogens).
- (e) To minimise the risk of dystocia and other health problems, the selection of sires for breeding (either natural or by artificial insemination) should take into account factors such as the dam's breed, size, age, and the sire's birthweight and birthing ease genetics, and the likely size of the offspring relative to the dam. This is especially important when hoggets or yearling heifers are mated before they have reached mature live weights.
- (f) Hoggets and heifers selected to be mated should be well grown, fed to allow for continued growth as well as pregnancy and carefully supervised around the time they give birth.
- (g) Animals, particularly males that are likely to lose condition during mating, should be healthy and in good condition (i.e. condition score 3 or more[7]) at the start of the breeding season.

Industry's view

Beef & Lamb New Zealand Genetics (B+LNZ Genetics), a subsidiary of industry good organisation Beef & Lamb New Zealand (B+LNZ), sees an ethical approach to breeding as focusing on producing productive but resilient animals that handle the natural variation in feed supply and climate while producing high quality products in the range of farm environments found in New Zealand.

Improved longevity, calf survival, and cow body condition score are key to such resilience. In addition, control of inbreeding, which in the past led to the build-up of deleterious recessive genes and inherited diseases, emphasises the need to maintain genetic diversity.

Selective breeding has brought significant improvements in animal health in the beef cattle industry, with selection for resistance to the facial eczema toxin and internal parasites. Selection for polled breeds obviates the need for disbudding/dehorning.

Many of the negative effects of selective breeding have come from taking a narrow view of performance based on very few traits. B+LNZ Genetics is undertaking research to develop suitable indexes for a range of farming environments. These indexes take a wide view of animal performance including growth, reproduction, health and disease traits.

A beef progeny test similar to the Central Progeny Test for rams is under development.

Issues noted by the NZVA included:

- Elimination of several congenital diseases in Angus cattle;
- Previously, heavy selection for meat production such as the double muscling gene in Belgian Blue cattle has produced negative outcomes such as dystocia (birthing difficulty) requiring surgical delivery of some calves.

NAWAC's view

NAWAC is satisfied that the beef industry's approach to selective breeding, focused as it is on the resilience of these animals in a variety of environments, is appropriate.

7 On a scale of 1 to 5.

Pigs

Code of welfare

The Animal Welfare (Pigs) Code of Welfare 2010 contains no information on breeding.

Industry view

In New Zealand there are two major pig breeding companies, namely PIC NZ Ltd and Waratah Farms Ltd. Both companies import genetic material from overseas (USA or Norway), thus the pig genotypes available to New Zealand pig industry have been selected overseas.

Breeding programmes in the international pig industry are highly sophisticated selecting for multi-dimensional characteristics.

The genetic structure of the pig industry is organised in three tiers: the nucleus herd where the selection within the pure breed (selected distinct genotype) occurs, the multiplier herd where crossbreeding between distinct genotypes takes place, mainly on the female side, and the commercial herd where all progeny are produced from the crossbred sow go to slaughter.

Negative effects of selective breeding have included:

- The so-called halothane gene which has been associated with increased muscularity and predisposes carriers to Porcine Stress Syndrome (PSS). This has effectively been bred out of New Zealand populations.
- Increased mature sow size which can cause welfare problems in older units where facilities have been designed for sows of a smaller size.
- Rapid weight gain which can result in leg weakness. Although the heritability for leg weakness is low to moderate, leg weakness, conformation or osteochondral lesions have been included in the selection process (Luther et al. 2007).
- Increased litter size which is associated with higher piglet mortality when there is no concurrent emphasis on piglet mortality and viability (Knap, 2013).

One of the advantages in the pig industry is that positive genetic gain can be brought about relatively quickly, again because of the large litter size, short gestation, and a relative lack of seasonal infertility. Selection criteria include leanness, efficient feed conversion ratio, feed intake, growth rate, meat quality (PSE, DFD, and intramuscular fat), fat quality, conformation (leg weakness), litter size, and piglet survival. Within breeding programmes, even factors that may be negatively correlated (for example, robust piglets and litter size) can be selected for simultaneously thus producing rapid genetic improvement.

NAWAC's view

- NAWAC has concerns about the fact that the vast majority of commercial pig genetics come from multinational organisations, planning selections years in advance. This means that New Zealand has little influence on the selection pressure applied to the animals. While these companies can in some cases demonstrate that they have made progress in welfare-related traits, due to commercial sensitivities they cannot be entirely transparent in the way they structure their selection index – for example, the relative weighting given to each trait. NAWAC would encourage greater transparency from these breeding companies.
- The nature of breeding within the pig industry – sows average 2.3 litters per year - means that 40 percent of sows have to be replaced each year, each sow on average having only a two and a half year productive life. NAWAC acknowledges that the industry has successfully worked to reduce the replacement rate through genetic selection and now chooses to balance longevity with the benefits of high genetic turnover. NAWAC encourages further work to increase longevity.
- Aggressive interactions between pigs can have a major impact on animal welfare. NAWAC is aware of research showing that "including social effects into the breeding programme affected aggressive behaviour, both at mixing and in stable groups, indicating changes in the way dominance relationships are established and in aggressiveness" (Rodenburg et al, 2010). NZPork representatives pointed out that care needs to be taken with breeding for behaviour as handlers need to be

able to 'read' the animal and know when it's in pain, for example. Breeding for pigs that don't express frustration, for instance in tail biting, doesn't necessarily fix the underlying problem, but simply hides the reaction. However, NAWAC sees a difference between a display of aggression and a demonstration of symptoms of pain. Turner et al (2008) suggest using visual lesion scores following mixing as an indicator trait for selection for reduced aggressiveness (as a complement to efforts to improve the environment).

- Given that the level of tail-biting in New Zealand is such that routine tail docking is undertaken, NAWAC would encourage breeding away from the propensity to tail bite so as to reduce the need for this painful husbandry procedure. While there appear to be differing opinions on the heritability of a reduced predisposition to tail-biting, the following references – Breuer et al, 2005 and the EFSA Panel of Health and Welfare[8] – have found a high enough heritability for selection. NAWAC also encourages environmental enrichment and requires manipulable material to be supplied to nesting sows.
- The gradual increase in sow size without concomitant increase in the size of sow facilities in some units is of concern. NAWAC would contend that sow size should dictate the size of facilities and sow welfare should not be impacted through being confined in facilities which are too small for them.
- The link between litter size and piglet mortality is a major factor in the continued confinement of sows in farrowing crates. NAWAC encourages the work already being done to increase piglet survivability through selection, but is concerned that survivability is also being maintained through management practices like farrowing crate use and fostering by nurse sows. NAWAC believes that industry should work to improve piglet survival though:
  - Breeding for non-crushing sows (who spend more time making nose-to-nose contact with their piglets before lying down and react more quickly to piglet distress calls),
  - Breeding for good physiological sows (optimal uterine environment, maternal behaviour, lactation output),
  - Breeding more robust piglets that are less susceptible to being crushed.
- NAWAC would encourage the focus to be switched from breeding an increasing number of piglets to breeding fewer, but more robust piglets. For example, given that there is now a mismatch between piglets per litter and number of teats, NAWAC would encourage a move towards smaller litters rather than breeding to increase the number of teats.

8 http://www.efsa.europa.eu/en/efsajournal/pub/611.htm

Poultry

There are many different breeds and strains of poultry in New Zealand, but in commercial production there are really only two types – layers and meat chickens. While the distant origins of the two are the same, selective breeding over many years has resulted in laying hens whose egg production rose from 130 in 1975 to 312 in 2008, and meat chickens whose rapid growth rate has them ready for slaughter within 5 or 6 weeks of hatching.

Codes of welfare

The Animal Welfare (Meat Chickens) Code of Welfare 2012 specifically excludes breeder birds, because at the time of its publication, a separate code of welfare to directly address welfare in relation to breeding and genetic selection was under development (but to date has not been published). The code does note "the relationship between meat chicken genetics (i.e. the selection of meat chicken breeds to show particular traits, such as strong legs) and the health and welfare of meat chickens. Meat chicken breeding companies are working to improve meat chicken leg and cardiovascular health and meat chicken grower companies should do all they can to encourage this". The code also notes that "the genetic selection of meat chicken stock in order to improve the welfare of meat chicken grower birds is important and is intended to be covered in a future code of welfare for meat chicken breeders".

The Animal Welfare (Layer Hens) Code of Welfare 2012 contains no information on breeding.

Industry view

The genetics for the majority of both commercial layer hens and meat chickens in New Zealand are sourced from international companies – Hy-Line International and ISA for layer hens, and Aviagen and Cobb for meat chickens. The New Zealand poultry industry helped NAWAC to seek responses from the four international companies; their submissions should be seen as representing the New Zealand poultry industry.

Submissions from two international companies which control the genetics within the meat chicken industry provide evidence that animal welfare has an increasing role to play in decisions around selective breeding. The poultry industry states that animal welfare has been and will continue to be a core part of poultry breeding programs and improvement in a range of welfare indicators has been made over the past few decades. Customer and society pressures are strong and this is constantly communicated to the breeding companies, who consider that seeking feedback from society and customers and taking into account the outlook of global developments is an integral part of the breeding development process. A concentration on such issues as leg health and maintaining genetic diversity, for instance, are apparent.

While the rapid growth rate has been blamed for many of the welfare problems in meat chickens, Dawkins and Layton (2012) challenge the assumption that this is necessarily incompatible with good welfare, as well as that feed restriction in adults is inevitable with fast-growing juveniles. They see "making use of all available genetic variation from existing breeds and other sources, and selecting birds in the range of environments they will encounter in commercial production" as the way forward to resolving the conflict between production goals on the one hand and welfare goals on the other. The breeding companies submit that due to balanced breeding many traits, even antagonistic ones, can be improved at the same time.

In layer hens, genetic selection has been largely production focussed although ISA demonstrated an increasing focus on health and welfare traits since the 1960's in their submission. The submissions from Hy-Line and ISA both mention the term "liveability", which is taken to mean adaptation to multiple different production environments. Animal wellbeing is listed as "continuing to have a significant selection emphasis along with production, egg quality, efficiency and environmental-impact traits". Both companies identified genomic selection as an exciting emerging technology.

All four breeding companies work according to Code-EFABAR[9], a voluntary code of good practice in support of responsible farm animal breeding.

9 http://www.responsiblebreeding.eu/

Layer hens

As noted in the introduction to this opinion, through selective breeding alongside improvements in health, nutrition and stockmanship, the average number of eggs a hen laid per year in New Zealand rose from 130 in 1975 to 312 in 2008. Genetic balance is delicate and improvement in one trait has to be made with a consideration of other desirable characteristics. Selecting for low mortality in layer hens can result in birds that are less fearful and less sensitive to stress, which is associated with competitive social interactions like feather pecking (Rodenberg et al. 2010).

Meat chickens

Selection for high juvenile growth rate, breast-meat yield and efficiency of feed conversion has left meat chickens vulnerable to welfare problems such as cardiovascular disease, and lameness or difficulty in walking (Webster, Cameron and Rogers 2013; Dawkins and Layton 2012). Such traits also cause problems for those birds that are selected as breeders and grown through to adulthood, and it is only through restricting the food to these older birds that problems such as obesity, difficulty mating, high mortality and locomotory problems can be minimised. However, food restriction is in itself a welfare issue. The EFSA Scientific Opinion on welfare aspects of the management and housing of grandparent and parent stocks raised and kept for breeding purposes (2010) states that "there is substantial evidence that this feed restriction has negative effects on broiler breeder welfare", leading to chronic hunger, increased performance of abnormal behaviours, increased pecking at non-food objects, and increased pacing. It also calls for more research into alternative feeding programmes and their effect on bird welfare.

NAWAC's view

- NAWAC has concerns about the fact that the vast majority of commercial poultry genetics come from multinational organisations, planning selections years in advance. This means that New Zealand has little influence on the selection pressure applied to the animals. While these companies can in some cases demonstrate that they have made progress in welfare-related traits, due to commercial sensitivities they cannot be entirely transparent in the way they structure their selection index – for example, the relative weighting given to each trait. NAWAC would encourage greater transparency from these breeding companies.
- Numerically, the meat chicken industry, producing approximately a hundred million birds annually, is the largest animal industry in New Zealand so any compromise to welfare is far-reaching.
- NAWAC has concerns that the meat chicken has been selectively bred beyond a point that is compatible with survivability. While the committee understands that the vast majority of these animals are slaughtered within weeks of hatching and so have no requirement to survive as such, NAWAC is concerned that the rapid growth of these animals has a negative effect on the birds that are kept in adulthood - for example affecting their fertility, mortality, locomotion, and aggressiveness (Dawkins and Layton, 2012). These problems are commonly dealt with via feed restriction in adult birds. NAWAC acknowledges the work done already to improve welfare in breeding birds, but would still strongly encourage a higher weighting of welfare traits as compared to production traits in genetic selection, including those that reduce the need for food restriction in breeder birds.
- NAWAC notes that many of the welfare problems that arise with layer hens are behavioural, which will naturally have flow-on effects for production. Jones and Hocking (1999) cite a study where the benefits of genetic selection against fearfulness and feather pecking were demonstrated, improving both welfare and productivity. The committee would encourage selection against the more marked aggressive tendencies within the layer hen population.
- Bone fractures in layer hens are prevalent in all systems, with incidences of up to 30% over the laying period (Whitehead and Fleming 2000; Gregory and Wilkins, 1996) but are a particular problem in systems where more space and perches are provided (NAWAC 2012). However, research supports that selecting for high bone strength can reduce the incidence of bone fractures (Bishop et

al. 2000).

- NAWAC supports the international layer hen companies in selecting for birds that are adapted to alternative production environments (e.g. barns with outdoor access) and would encourage New Zealand producers to take advantage of these genetics.

Overbreeding

NAWAC would strongly recommend the uptake of embryo sexing technology (for example, spectroscopic sex determination in the egg) in the layer hen industry as soon as it becomes available for commercial use so as to avoid the need for maceration of the large numbers of male chicks.

Deer

Code of welfare

The Animal Welfare (Deer) Code of Welfare 2007 contains no information on breeding.

The deer industry did not make a submission although the NZVA submission included material from the Deer Branch.

The species is relatively recently domesticated in New Zealand, so any effects of selective breeding are less evident than in other agricultural species. However, the NZVA noted the many positive breeding initiatives within the industry. As an example, Pearse and Amer (2002) point out that the use of genetic evaluation has resulted in moderate and steady genetic gains in the major traits, particularly liveweight gain at specified ages and a variety of records involved in 2 year old velvet production, including weight, grade and potential for hard antler.

However, the recent domestication of deer does raise some interesting and unique questions. For example, Fisher and Bryant, 1993 noted that in the wild, stags maintain a harem, with competition amongst males ensuring that the fittest/strongest prevail to pass on their genes – a "potent selective force" in maintaining fitness of the species. They raised the possibility that, as selection moves from natural to artificial, it may counter natural selection favouring fitness.

NAWAC's view

- NAWAC believes that, because the species is relatively recently domesticated, the deer industry has the opportunity to avoid many of the breeding issues that have arisen in other species.

Farmed fish

Code of welfare

There is currently no code of welfare that contains information on breeding fish.

Industry view

The focus of intensive fish farming in New Zealand is the King salmon (also called Chinook salmon, *Oncorhynchus tshawytscha)*, an introduced species. They are raised in sea pens in the Marlborough Sounds, Akaroa Harbour and Stewart Island, with the freshwater hatching and grow-out in Canterbury, Otago and Tasman.

The New Zealand King Salmon Company, which dominates production, has its own well developed selective breeding programme which has improved growth and quality (Walker et al, 2012).

The industry seeks to improve growth rate (better production returns from available water space) and feed conversion efficiency (to reduce environmental footprint and mitigate against feed cost increases), within appropriate length:weight proportions and with continued improvements in resilience of fish. A range of technologies are utilised to ensure that fish with natural physiology are selected for the breeding programme. This includes radiography (to exclude skeletal malformations), and near infrared spectrometry (for fillet quality measures). They believe there is no pressure to select for exaggerated physical characteristics.

NAWAC's view

- There are some unique considerations when thinking about salmon breeding and animal welfare; for example, each individual can produce many more offspring compared to terrestrial animals, which means the impact (positive or negative) of genetic gain can be brought about very quickly.
- The intensive nature of fish farming has brought about some welfare problems that don't yet have a clear cause but may be tied to selective breeding – these include cataracts, skeletal malformations and soft tissue abnormalities including cardiac deformities (CIWF and WSPA, 2007; Farm Animal Welfare Committee, 2014). NAWAC would encourage the industry to continue to work on reducing the occurrence of these conditions.
- Since this is a relatively new industry (New Zealand's first salmon farm was established in 1976), NAWAC encourages salmon breeders to use the knowledge gained from other intensive industries to ensure that robustness and health should be a part of breeding programmes from the beginning.

Non-Production Animals

Horses

Code of welfare

The Animal Welfare (Horses and Donkeys) Code of Welfare, which was issued 29 January 2016, contains a section on Breeding and Rearing (Section 6). There is currently no mention of genetic disorders in this section; rather, the emphasis is on issues of care and stockmanship that relate directly to the welfare of breeding stock and foals. In particular, Section 6.3 (Reproductive Technologies and Selection of Animals for Mating) acknowledges how modern breeding technologies have been used to facilitate genetic gains in horses.

Information drawn in part from the New Zealand Equine Veterinary Association (NZEVA)

As with all domestic animal species, horses have been selectively bred for centuries. Fortunately, because physical function has been a critical breeding objective – there is a broad consensus (shared by the NZEVA) that most horse breeds have relatively few welfare-compromising genetic disorders resulting directly from selecting for a particular conformational trait. That said, a comprehensive study of the international literature by Bettley et al (2012) found that breed popularity and number of inherited disorders were correlated, and that the greatest number of conformational disorders were found in the Miniature Horse, where it may be argued that the selection pressure for function may not be as great. In addition, a 'founder' (or 'popular sire') effect leading to the genetic condition hyperkalemic periodic paralysis (HYPP) which has been associated with Quarter Horses and breeds derived from this breed due to the intensive use of stallions that were particularly successful in the show ring.

Individual breed associations have some control over the breeding of purebred horses in New Zealand through regulations associated with the registration of breeding stock. For example, the American Quarter Horse Association of New Zealand and the Paint Horse Association of New Zealand both require that breeding stock be tested for five of the known genetic disorders that are associated with the Quarter Horse, and breeds derived from the Quarter Horse.

In addition, the New Zealand Miniature Horse Association requires a Certificate of Soundness for stallion registration. The certificate requires a veterinary examination, and freedom from a number of genetic disorders and/or undesirable traits.

In New Zealand, the Equine Parentage and Animal Genetic Services Centre based at Massey University offers DNA-based genetic testing services for breed societies and individual owners.

NAWAC's view

- Although not all breed associations may have stringent regulations governing the selection and registration of breeding stock, and there is little or no formal control over the breeding of non-registered animals, indiscriminate breeding of horses is not believed to be a major welfare issue in New Zealand.
- We support the efforts of the NZEVA, to educate and advise both breeders and the general public on the existence and diagnosis of inherited conditions, and to encourage breeding practices which select against known inherited diseases.
- The impact of selective breeding on behaviour and temperament should also be considered by breeders. For example, fearful reactions in horses can be affected by genetic selection (Hausberger et al, 2004).

Overbreeding

NAWAC is aware that concerns have been raised about wastage (i.e. the number of horses leaving the industry) in New Zealand's racing industries. However, the committee does not see "leaving the industry" as an animal welfare issue in itself. Although statistics on the number of horses have not been routinely collected except for those animals

on farms (51,611 on 30th June 2014[10]), once non-agricultural horses are added the figure rises to somewhere over 100,000 (NZTR, pers comm). MPI's slaughter statistics give a figure of only 1175 for horses commercially slaughtered in the year to September 2015.

NAWAC is aware that New Zealand Thoroughbred Racing (NZTR) and Equestrian Sports New Zealand (ESNZ) have launched a joint initiative aimed at increasing opportunities for second careers for Thoroughbred horses retiring from racing and raising awareness of the adaptability of Thoroughbreds for second careers in equestrian sport. The initiative, titled Thoroughbreds in Equestrian Sport (TiES), also aims to increase links between the Thoroughbred racing industry, the wider equestrian community and the public to stimulate uptake of ex-racehorses for second careers.

10 http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7423

Dogs

Code of welfare

The Animal Welfare (Dogs) Code of Welfare 2010 has a section on breeding (Section 6) which addresses the issue of unplanned breeding leading to unwanted animals in the introduction. In relation to welfare issues arising from planned breeding, the code has one minimum standard:

- Breeders must make all reasonable efforts to ensure that the genetic make-up of both sire and dam will not result in an increase in the frequency or severity of known inherited disorders.

And four recommended best practices:

- Breeders should report the occurrence of inherited disorders to the New Zealand Kennel Club Canine Health committee to assist progress in reducing these disorders and identify carrier dogs.
- Breeders should follow a documented scheme that allows for monitoring and eventual prevention of known inherited disorders.
- Dogs and bitches should not be kept together if there is a risk of accidental mating.
- All dogs being considered for mating should be tested for inherited disorders where such tests are available. For those inherited disorders where no suitable test is available, occurrence of inherited disorders in their genealogy should be assessed. Veterinary or other appropriate advice should be sought in this respect.

Breeders' views

There are two groups that have some control over the breeding of some dogs: the New Zealand Kennel Club (NZKC) and New Zealand Greyhound Racing Association (NZGRA). Outside of these groups, there are any number of dog owners who may or may not breed their animals, or allow them to breed indiscriminately.

A key driver for the NZKC is maintaining the gene pool while producing 'fit for purpose' dogs with good temperaments. As an ethical approach to selective breeding, the NZKC has developed an accredited breeders scheme which regulates the close breeding of related animals and encourages the use of health testing for 'important' breed-related diseases. This is a voluntary scheme and at the time of writing, information from the NZKC Director Secretary indicates that there are 75 accredited breeders from an estimated pool of 700-800 active breeders, although an indeterminate number of non-accredited breeders do undertake genetic testing as well.

As a caveat to its aim of using testing to reduce and remove harmful genes from the population, the NZKC notes that care must be taken to ensure that removing carriers of deleterious genes from a breed with relatively low numbers doesn't result in an unsustainably small gene pool. Further to that, the NZKC finds artificial insemination using imported semen as a good way to broaden the genetic base present in New Zealand, but encourages breeders to source semen from health-tested animals.

The NZKC has recently appointed a Canine Health Officer with the key task of growing the number of accredited breeders as well as the amount of testing. Alongside this, judges are being encouraged to take into account the health and welfare of dogs to encourage breeding 'fit for function'.

NAWAC's views

- NAWAC is concerned at the number of inherited diseases and defects that affect pedigree dogs, some but not all of which relate to breed standards (Asher et al, 2009). There are said to be almost 400 inherited disorders in the 50 most popular breeds (Summers et al, 2010). While the NZKC has had reasonable recognition of inherited disorders that affect health and welfare, the committee has concerns that conformational disorders that are intrinsic to breed standards but that impact on animal welfare such as brachycephalism have not been recognized previously. The committee is pleased to note that the NZKC has recently moved to investigate and consider these broader traits in their genetic programmes.
- NAWAC agrees with the significant concerns expressed by the NZVA about brachycephalic dogs in their submission:
  "Brachycephalic dog breeds (Bulldogs, Pugs,

Pekingese etc.) are subject to Brachycephalic Obstructive Syndrome leading to lifelong upper respiratory disease (breathlessness) and ocular disease. Dystocia due to exaggerated fetal head diameter and feto-pelvic disproportion is also a significant issue. Many of the pups of these breeds require delivery by caesarean section, and some bitches in this country are subject to repeat surgical intervention for the purposes of reproduction". Several reports have raised concerns around brachycephalic dogs, including the Bateson Inquiry into dog breeding (2010), and a report by the UK Society for the Protection of Animals (Rooney and Sargan, 2009). Other examples include the much higher incidence of corneal ulcers (Packer et al 2015), difficulty breathing (Beausoleil and Mellor 2015), and predisposition to gastrointestinal abnormalities (Poncet et al 2005) associated with brachycephalic breeds.

- There are likely to be many breeders, both within and outside the NZKC, who do not test their dogs prior to breeding. NAWAC recommends that where there are tests available for known inherited diseases or defects, these should be used before a breeding programme is undertaken.
- However, a lack of technology should not be viewed as a barrier to improve welfare in affected dog breeds. Some conformational and inherited disorders are intrinsic to breed standards and these could be addressed without genetic technology.
- NAWAC supports the NZKC accredited breeders code of ethics which states that accredited breeders will not breed from a father-daughter, brother-son or brother-sister pair, but shares concerns with NZVA in regards to the practice of 'line breeding' where animals are selectively bred with a close relative (e.g. aunty/nephew, grandparent/grandchild). This is done to 'fix' a desired feature in the population but the limited gene pool caused by continued linebreeding can lead to genes that negatively affect welfare becoming widespread.
- The NZVA's move to adopt the Penn Hip scheme[11] for the detection of canine hip dysplasia signals a positive move by the profession to improve the welfare of dog breeds susceptible to this disease.
- The impact of selective breeding on behaviour and temperament should always be considered by breeders. Dog behaviour varies between breeds of dogs, implying a genetic basis (Bradshaw et al 1996). As an example, dogs selected to work may experience poor welfare if they are unable to meet this behavioural need.
- NAWAC would encourage education and understanding of all groups (including breeders and buyers) on what the term 'fit for function' means in the context of dog breeding. NAWAC is concerned that buyers and breeders continue to breed or acquire dogs with conformational disorders that are well understood to contribute to poor welfare, such as brachycephaly. Such dogs may be 'fit for function' in that they can adequately function as companions; however, these animals may have their physical, health and behavioural needs compromised by their genetic status. If that is the case then they should not be accepted as an animal that is 'fit'. One study indicated that over half of brachycephalic dog owners do not recognise breathing abnormalities in their pets as a health problem (Packer et al, 2012).
- NAWAC would encourage education of all groups (including breeders and buyers) on where potential liability will lie if animals bred to a certain phenotype don't fulfil the requirements of the purchaser.

Overbreeding

The number of puppies born each year far outweighs the number of suitable available homes. Euthanasia of stray or unwanted dogs is mainly undertaken by local councils and SPCAs. While it is difficult

11 PennHIP is a multifaceted radiographic screening method for hip evaluation. The technique assesses the quality of the canine hip and quantitatively measures canine hip joint laxity. The PennHIP method of evaluation is more accurate than the current standard in its ability to predict the onset of osteoarthritis (OA). Osteoarthritis, also known as degenerative joint disease (DJD), is the hallmark of hip dysplasia (HD).

to get collated statistics for the numbers of dogs euthanased by councils, figures from the RNZSPCA, which has a philosophy of saving as many animals as possible, still show that over the four years up to 2015, an average of 2770 dogs and puppies were put down annually.

Many councils have reduced registration fees for neutered animals. However, it is likely that much of the indiscriminate breeding occurs in unregistered dogs.

Puppy farms are of concern to NAWAC and the committee welcomes the new initiative from TradeMe in association with the NZVA and the RNZSPCA to set standards for the sale of dogs and puppies through the website, but acknowledges that TradeMe is not the only way to buy pets online and that their standards are voluntary.

NAWAC is aware that, following concerns from the public, NZGRA has made determined efforts to reduce the number of greyhounds being both bred and euthanased.

NAWAC remains uncertain about the number of dogs which are being produced or imported each year, and where they will end up once their racing career is finished; in particular as even high grade dogs tend to only have a racing life of 1–4 years. Whilst re-homing through Greyhounds as Pets is offering one avenue for these dogs, there is a risk of this avenue reaching saturation point given the length of a dogs lifespan vs its racing life duration.

We understand that NZGRA is on target to halve the oversupply of dogs by 2017. This is being achieved through the introduction of fees for each puppy registered; restrictions on breeding bitches under 15 months and over 8 years; and the requirement that bitches must have a clear season after two consecutive litters.

Cats

Code of welfare

The Animal Welfare (Companion Cats) Code of Welfare has a section (Section 6) on breeding that addresses the need for desexing to minimise the unwanted cat population. Issues relating to inherited disease or conformation are not addressed in the code.

Breeders' views

There are two groups that have some control over the breeding of some cats: the New Zealand Cat Fancy (NZCF) and Catz Incorporated (CatzInc). Outside of these groups, there are any number of cat owners who may or may not breed their animals, or allow them to breed indiscriminately.

The New Zealand Cat Fanciers (NZCF) organisation considers it important to identify harmful genetic conditions and is aware of a number of different inherited diseases affecting pedigree breeds worldwide. They say there is a general awareness amongst breeders of the risks involved from repeated inbreeding over several generations, but the importance of educating breeders about breeding away from harmful genetic conditions is acknowledged. In terms of mitigating negative effects of selective breeding, the NZCF has indicated that it is developing a breeding policy for each recognised breed that will recommend testing protocols for harmful genetic conditions. This will be a voluntary scheme unless the breeders themselves endorse a compulsory programme. NZCF also has a Breed Standards Advisory Committee which reviews issues around selective breeding, including allowing some outcrossing to maintain a larger gene pool and minimise inbreeding. While NZCF sees genetic testing as useful technology, there is some concern that the tests available locally are limited.

NZCF does recognise the potential for unwanted harmful effects to arise from breeding selectively for appearance, such as the respiratory problems that can occur in brachycephalic breeds.

NZVA views

The NZVA's Companion Animal Society (CAS) has expressed concern regarding the Scottish Fold breed of cats. The abnormal ear shape of the breed is the result of a developmental abnormality called Feline Osteochondrodysplasia or degeneration of cartilage surfaces in the body, progressing to severe and painful degenerative joint disease. Cats which are homozygous for the abnormal gene progress rapidly to progressive crippling degenerative joint disease early in life, while heterozygotes exhibit slower, albeit still significant degeneration (see also Takanosu et al, 2008). Overseas recommendations are to discontinue breeding due to animal welfare issues. The breed has been banned by Federation Internationale Feline and Cat Fancy UK. The Companion Animal Society of the NZVA would like to see the cessation of breeding this breed and its crosses in New Zealand.

The NZVA CAS also has concerns that if purebred cat breeding follows dog breeding trends, there will be an increasing occurrence of preventable inherited & conformational disorders in cats. Increasing facial deformity of Persian and Exotic Breeds is leading to dental malocclusion, marked upper respiratory tract disease and ocular disease. The increasing chronological progression of facial deformity over the last few decades has led to increasing disease and the reduced wellbeing of these breeds.

NAWAC's views

- While it is a concern that NZCF has no formalised process in place to manage genetic disease, no policies regarding this in their constitution and, crucially, no direct or linked information on their website about inherited disease, NAWAC notes that NZCF is currently drafting some policies to publish online and encourages this work.
- NAWAC supports the banning of the Scottish Fold breed on welfare grounds.
- While the NZCF does recognise that the brachycephalic breeds, such as Persians or Exotics, are susceptible to respiratory and ocular

problems (Farnworth et al, 2016), NAWAC is concerned that there seem to be no policies in place to ameliorate the situation.

- There are likely to be many breeders, both within and outside the NZCF, who do not test their cats prior to breeding. NAWAC recommends that where there are tests available for known inherited diseases or defects, these should be used before a breeding programme is undertaken.
- However, a lack of technology should not be viewed as a barrier to improve welfare in affected cat breeds. Some conformational and inherited disorders are intrinsic to breed standards and these could be addressed immediately without genetic technology.
- The committee sees a need for education of all breeders on what 'fit for purpose' means in the context of cat breeding. NAWAC is concerned that buyers and breeders continue to create a demand for cats with conformational disorders that are well understood to contribute to poor welfare, such as brachycephaly.
- NAWAC would encourage education on where potential liability will lie if animals bred to a certain phenotype don't fulfil the requirements of the purchaser.

Overbreeding

The number of kittens born each year far outweighs the number of suitable available homes. Euthanasia of stray or unwanted cats is mainly undertaken by local councils and SPCAs. While it is difficult to get collated statistics for the numbers of cats euthanased by councils, figures from the RNZSPCA, which has a philosophy of saving as many animals as possible, still show that over the past four years, an average of 15,338 cats and kittens have been put down annually.

NAWAC welcomes the new initiative from TradeMe in association with the NZVA and the RNZSPCA to set standards for the sale of cats and kittens through the website, but acknowledges that TradeMe is not the only way to buy pets online and that their standards are voluntary.

Registration and identification of cats has often been put into the 'too hard basket', but NAWAC suggests this may be one way of beginning to address the issue. The committee notes with interest the formation of the National Cat Management Strategy Group who are currently developing guidance on the issue and has membership from NZVA, the NZVA Companion Animal Society, New Zealand Companion Animal Council, RNZSPCA, Local Government New Zealand and the Morgan Foundation, with advice from DOC and MPI. NAWAC agrees that there are animal welfare problems associated with stray and feral cats and is willing to work with the group as it consults on a national cat management strategy.

Ornamental fish

Code of welfare

There is currently no code of welfare that contains information on breeding fish.

Industry view

There is little formal control over the breeding of ornamental fish. The Federation of New Zealand Aquatic Societies (FNZAS) does run a national breeding scheme, which acknowledges the achievements of FNZAS members in breeding fish.

Ornamental fish are often imported into New Zealand for sale. Fish are the most numerous pet in New Zealand, with a total population of 1.7 million kept across 11% of all New Zealand households; the large majority (71%) of fish are purchased from pet shops (NZCAC 2011).

NAWAC's view

Ornamental fish have been selectively bred over centuries into a huge array of domesticated varieties. Some varieties have been bred for exaggerated features - for example, the bubble-eye goldfish (Whitaker, 2001) or the aggressive Betta splendens (Todd 2008; Verbeek 2007) and many others - that affect their feeding, locomotion, behaviour and/or reproduction, which may in turn affect their welfare. While the welfare impacts of some of these extreme variants of ornamental fish have not been studied extensively, NAWAC would contend that where their physical, health and behavioural needs (as outlined in the 1999 Animal Welfare Act) are affected, their welfare will be impacted negatively.

NAWAC would encourage breeders of ornamental fish, here or overseas, to consider health and welfare alongside looks when selecting fish to breed from.

Animals in zoos, aquariums and wildlife parks

Code of welfare

Section 3.7 in the Animal Welfare (Zoos) Code of Welfare 2005 deals with the management of animal reproduction, with the introduction stating "To ensure the future of an animal population, or to avoid the problems of surplus animals for which there is no satisfactory future, the operator is responsible for ensuring that animals in their collection breed on a planned basis".

Minimum Standard 5 states that "The breeding of animals must be managed so as to prevent overpopulation or overcrowding resulting in unnecessary pain and distress".

There is one recommended best practice:

- Breeding of each animal or animal group should be managed in a way that is consistent with the long-term welfare of the animal and with this code. With regard to special breeding programmes, ARAZPA (now ZAA) should be consulted. In the case of New Zealand native species, the recommendations of the CMaG (Conservation Management Group)[12] Species Co-ordinator should be followed and permission from the Department of Conservation may be required (check permit conditions).

General information:

- Animals of different taxonomic groups (e.g. sub-species) should not normally be allowed to inter-breed. Where practised, it should not compromise the genetic integrity of the animals within a managed conservation breeding programme.

Industry views (Zoo and Aquarium Association)

The ZAA approach includes:

- Breeding to a planned approach whereby all resultant animals welfare can be supported.
- Breeding animals where the outcomes optimise the health of the animals.
- Breeding animals that can contribute to conservation outcomes.
- Not selectively breeding for rare colour traits in our managed species programmes.

12 Now amalgamated with ZAA.

The aim is to minimise the effects of inbreeding which can result in lack of reproductive output and/or overall fitness. ZAA utilises internationally recognised software for the management of their studbooks and population analysis. They currently work with universities and museum genetic forensic specialists to analyse populations for levels of relatedness and the identification of allelic diversity.

The ZAA code of practice has a section on animal breeding, which aims to promote genetic diversity by utilising the least related animals and so minimise inbreeding, and states:

Acknowledging responsibility for all animals produced within their collection, Association institutions:

- *Take action to avoid the production of unwanted (Animals not planned to be held in the breeding institutions, and for which there is no reliable demand elsewhere) animals through unplanned breeding (e.g. by employing commonly used techniques such as contraception, neutering and separation of the sexes).*
- *Do not selectively breed, import or otherwise obtain wildlife with characteristics not representative of corresponding wild populations, unless it can be demonstrated, that the result of such will assist in delivering a positive message about conservation values and the conservation of wildlife, or where such acquisitions are in response to animal welfare-directed requests from government or non-government organisations. Spaces needed for direct conservation and/or education purposes should not be compromised by such a decision.*
- *For programme species for which population management is coordinated regionally, select pairings in accordance with the recommendations of the Captive Management Programme.*

NAWAC's view

While the committee feels that the ZAA approach aims to minimise welfare impacts through selective breeding, NAWAC does have concerns about institutions that manage wild animals but are not part of an association which requires compliance with its codes of practice for accreditation, or, in some cases,

no regular auditing. NAWAC suggests that all such institutions should be required to have, and comply with, a peer-reviewed breeding plan.

Overbreeding

The code of welfare states the following in the introduction:

Euthanasia may be warranted, as a last resort, when attempts to find a satisfactory alternative solution have failed:

- *When births occur despite animals being on a controlled breeding programme, i.e. unwanted pregnancies;*
- *if an operator is unable to comply with this code of welfare and there is no suitable alternative accommodation for the animals;*
- *when there is over-representation of a particular sex or genetic line.*

ZAA has a policy on euthanasia, and NAWAC recommends that non-ZAA institutions should have a breeding plan which includes the management of populations.

Conclusions

1. NAWAC considers it unethical to knowingly use animal breeding programmes that produce animals whose physical, health and behavioural needs are compromised by their genetic status.
2. NAWAC considers it unethical to fail to prevent indiscriminate breeding of animals for which there is no reasonable hope of responsible ownership.

Looking to the future

This paper focuses on selective breeding, however, new and emerging technologies such as genetic modification and cloning will have an impact on animals in the future. The National Animal Ethics Advisory Committee (NAEAC), who advise the Minister for Primary Industries on ethical and animal welfare issues relating to the use of animals in research, testing and teaching, has policies[13] on cloning and producing genetically modified animals. The impacts of new technologies will be considered by NAWAC as they become more commonplace to New Zealand farmers and breeders.

NAWAC does also have concerns that sustainable intensification to reduce the impact of livestock production on the environment could result in more emphasis on high-producing, biologically efficient livestock rather than welfare (Garnett et al, 2011). There is potential for selection to leave behind hard to measure traits with lower heritability, like disease resistance, when compared to easier to measure production traits. NAWAC has found that livestock industries are already selecting for welfare traits, and it is important that this continues.

NAWAC supports goals to reduce the use of antibiotics for the maintenance of animal health and wellness, and considers that selective breeding for robustness will be part of the approach to deliver high welfare for animals in a future with limited or no access to prophylactic antibiotics.

13 https://www.mpi.govt.nz/protection-and-response/animal-welfare/overview/national-animal-ethics-advisory-committee/naeac-publications/

Recommendations

NAWAC recommends:

1. That animal welfare issues, including physical health, species-specific behaviour and mental health, are taken into account when animals are selectively bred for specific traits and that these are articulated in breeding programmes;
2. That where there are tests available for known inherited diseases or defects, these should be taken into consideration before a breeding programme is undertaken;
3. That breeding programmes are planned to maintain or increase genetic diversity;
4. That all efforts are made to ensure that breeding is planned to minimise the euthanasia of "surplus" animals, with a greater level of encouragement to reduce indiscriminate breeding of companion animals and a greater use of technology that reduces the need for euthanasia of animals of an unwanted sex;
5. That there is a change in culture that sees particular traits as desirable or undesirable solely for aesthetic reasons;
6. That, where this is not happening already, there is a move towards breeding programmes or reproductive technology that might contribute to improving an existing adverse situation;
7. That there is transparency by private breeding programmes on which individual traits are selected for, and the relative weighting of production vs. production traits in the selection index;
8. That care is taken to ensure that breeding for certain behaviours that are potentially beneficial to enable easier handling, particularly in animals that are confined in artificial environments, does not result in a loss of telos.

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Appendix one – initial submissions

NAWAC's invitation to contribute

National Animal Welfare Advisory Committee

Consultation: Selective Breeding and Animal Welfare

There are many illustrations of the spectacular success of selective breeding. As an example, through selection, the average number of eggs a hen laid per year in New Zealand rose from 130 in 1975 to 312 in 2008, while lambs weaned per 100 ewes per year rose from 100 in 1991 to 124 in 2003. Again, selective breeding can lead to improved natural resistance to internal parasites. With respect to companion animals, selective breeding has given us the wide range of dog breeds available, from the tiny Chihuahua to the Great Dane.

However, there have also been unintended negative effects. Selecting for traits that are seen as desirable, whether that be for increased production, efficiency of feed conversion or the way an animal looks, can impact on animal welfare - examples include inherited disease and significant structural changes that interfere with normal functioning.

The National Animal Welfare Advisory Committee (NAWAC) is required to advise the Minister for Primary Industries on any matter relating to the welfare of animals in New Zealand. With this mandate in mind, as well as the legislative requirement that owners and persons in charge of animals must take all reasonable steps to ensure that the physical, health and behavioural needs are met in accordance with good practice and scientific knowledge, the Committee would like to ensure that animal welfare issues are taken into account when animals are bred for specific traits.

We are planning a consultation process with stakeholders to look at a number of different issues associated with the welfare effects of selective breeding. As part of that process, we would like to hear your views on the following questions:

1. What does your organisation see as an ethical approach to selective breeding?
2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?
3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?
4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?
5. What does your organisation see as the key drivers for the future in terms of selective breeding?
6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

As a part of the consultation process, NAWAC will meet with those stakeholders who would like a face-to-face meeting. Others may prefer to answer the questions posed above in writing. We look forward to hearing your response.

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New Zealand Veterinary Association

15 November 2014

National Animal Welfare Advisory Committee
Selective Breeding and Animal Welfare Sub-committee
c/o MPI, Pastoral House
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Wellington 6140
New Zealand

To the Selective Breeding and Animal Welfare Sub-committee

Re: Consultation on selective breeding and animal welfare

The New Zealand Veterinary Association (NZVA) welcomes the opportunity to make a written submission on Selective Breeding and Animal Welfare

The NZVA is an Incorporated Society representing veterinarians, with approximately 2050 members. This represents over 75% of New Zealand domiciled veterinarians.

The high priority which the NZVA attaches to the promotion of good animal welfare practice is evidenced by the first object of the Association [Rule 2 (a)] which is:

> *"To promote the application of veterinary knowledge which benefits all members of the community and ensures that:*
>
> *(i) animals used by human beings in agricultural production are used effectively and that the quality of produce is acceptable to all markets;*
> *(ii) the health, welfare and performance of animals used by human beings for agricultural production, companionship, sport, protection, the advancement of knowledge or any other purpose are maintained at all times;*
> *(iii) wild and feral animals are treated with respect and consideration for their welfare."*

The NZVA produces numerous Guidelines, Policies, Codes of Practice and Standards in order to assist members in providing the highest standard of veterinary service for the community.

This submission draws on comment from the NZVA membership, in particular those Special Interest Branches whose members may deal with animals involved in breeding or those produced as a result of selective breeding as part of their practice, as well as those with a particular interest in animal welfare.

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1. **What does your organisation see as an ethical approach to selective breeding?**

Selective breeding has made a significant contribution to the well being of animals within NZ through improvements such as the exclusion of genetic diseases, increased disease and parasite resistance and improved physical traits. It has however, lead to significant animal welfare issues, particularly (but not exclusively) in the companion animal sector where phenotypical (physical) appearance has been selected for at the exclusion of other benefits and has lead to the progressively decreasing well being of certain breeds.

The NZVA believes that an ethical approach to selective breeding ensures that selective breeding is performed for the overall benefit of the breed or species and takes in to requirements the basic physiological needs of the animal so as to ensure its ongoing welfare.

Ultimately this infers the need to change breed standards to remove the emphasis on specific physical characteristics and focus on the overall health of the breed.

Ethical use of selective breeding requires an understanding of the part of the genome that the selective process is working on and what other phenotypic factors are likely to be affected by the process of effecting change on that genome. To achieve positive outcomes this requires:

a) Clear breeding objectives to consider and mitigate against unintended consequences
b) Monitoring change across time for both phenotypic and genotypic traits to allow consequences to be predicted and managed.
c) The development of monitoring and reporting systems to detect the emergence of rare recessive genes or undesired outcomes to allow appropriate and timely responses.

2. **What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?**

This a broad question when applied across the whole veterinary profession and the wide spectrum of animal species with which we work and is impossible to address in this format. However, some examples of positive and negative effects of selective breeding are as follows:

1. Companion Animals

The NZVA Companion Animal Society has expressed concern regarding the Scottish Fold breed of cats. The abnormal ear shape of this breed is the result of a developmental abnormality called Feline Osteochondrodysplasia. The presence of this gene results in degeneration of cartilage surfaces in the body progressing to severe and painful degenerative joint disease. Cats which are homozygotes for the abnormal gene progress rapidly to progressive crippling degenerative joint disease early in life while heterozygotes exhibit slower, albeit still significant degeneration, Overseas recommendations are to discontinue breeding due to animal welfare issues , the breed has been banned by Federation Internationale Feline and Cat Fancy UK. The Companion Animal Society of the NZVA would like to see the cessation of breeding this breed and its crosses in New Zealand.

Similarly increasing facial deformity of Persian and Exotic Breeds is a cause for concern leading to dental malocclusion, marked upper respiratory tract disease and ocular disease.

The increasing chronological progression of facial deformity over the last few decades has led to increasing disease and the reduced well being of these breeds.

Brachycephalic dog breeds are subject to Brachycephalic Obstructive Syndrome (Bulldogs, Pugs, Pekingese etc.) leading to life long upper respiratory tract disease (breathlessness) and ocular disease. Dystocia due to exaggerated foetal head diameter and foeto-pelvic disproportion is also a significant issue. Many of the pups of these breeds require delivery by caesarean section and some breeding bitches in this country are subject to repeat surgical intervention for the purposes of reproduction.

The movement of the New Zealand Veterinary Association to exclusively adopt the Penn Hip scheme for the detection of canine hip dysplasia is a world first and signals a positive move by the veterinary profession to improve the welfare of dog breeds susceptible to this disease.

2. Production Animals

The use of selective breeding in the production animal sector has shown many examples of improved traits. Selective breeding in sheep has created significant positive increases in fecundity (twinning) and lamb growth rates, parasite resilience/resistance and resistance to facial eczema.

In beef cattle examples might be the elimination of several congenital diseases in Angus cattle and increased growth rates across breeds. There can however be potential negative outcomes of selection such as the recent issue of hairy dwarf calves. Previously heavy selection for meat production such as the double muscling gene in Belgian Blue cattle has produced negative outcomes such as dystocia (birthing difficulty) requiring surgical delivery of calves.

In dairy cattle the industry has seen a marked improvement in production over long periods of time . This was initially focussed exclusively on milk production but there have been negative correlations with fertility genotypes and phenotypes. Breeding organisations now use broader objectives (EBV's) to capture other traits that are not exclusively production focussed. There is a new focus on TOPs (Traits other than production) such as udder conformation to move away from production specific traits to a broader emphasis including traits that provide other benefits generally to bovine wellbeing.

In deer there have been many positive breeding initiatives within the industry. However, selection for antler size and weight (which has extremely high heritability) is a serious potential welfare issue. There has been significant concern expressed in North America with whitetailed bucks having been selected to produce antlers that are so big they can't lift their heads. There is concern within New Zealand to ensure these issues are not repeated here.

3. **What actions are being taken within your organisation to mitigate any negative effects of selective breeding?**

   The NZVA is engaged in collaboration between our members and the broader community to increase the awareness of welfare issues associated with selective breeding and both the potential positive and negative outcomes.

   Within the companion animal sector there is a renewed emphasis on the philosophy of wellness and the benefit of the animal as a whole. A rational and scientific based approach to breeding with the welfare of companion animals as its foundation is being advocated to owners and breeders alike. Collaborative bodies such as the New Zealand Kennel Club Inherited Disease Committee and the New Zealand Companion Animal Council are fundamental to the progression of this cause. Improved communication between vets, breeders and the public will lead to increased awareness of animal welfare issues associated with selective breeding. The continued development of new DNA technologies allowing early disease detection in both breeding animals and their progeny is fundamental to reducing the incidence of inherited disease.

   Within the production and large animal sectors ongoing collaboration between scientists and vets has changed the focus of breed selection to broader EBV's including traits such as fertility and TOP's. Ongoing engagement between vets and producers will see further exclusion of genetic diseases and use of technology to address animal welfare issues associated with production, for example the use of genetic markers to identify short gestation and low birth weight bull sires, the sexing of dairy cow semen to reduce bobby calf production or eliminating micropthalmia in sheep breeds such as the Texcel.

   There is a need to ensure increased monitoring for any adverse outcomes to detect potentially rare but significant welfare effects after the introduction of new genetics – particularly through epidemiological studies of outcomes of the selective process. Veterinary epidemiologists will continue to play a vital role here and the collection of data and monitoring change across time for both phenotypic and genotypic traits will remain essential to progress.

4. **What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?**

The rapid development of gene identification and DNA technologies across the veterinary industry is the most valuable emerging technology for the management of breed selection based issues. This is evident in the companion animal sector where an expanding repertoire of DNA tests can be used for early disease identification both in breeding animals but also their progeny prior to purchase.

Similarly Single Nucleotide Polymorphism tests in sheep, beef cattle and dairy cattle for trait identification is an exciting and emerging new technology to facilitate the selection process.

There needs to be increased emphasis now across all aspects of the industry producing good phenotypic data of the outcomes of breeding. This will facilitate the role of geneticists through good

information collection through vets, owners, breed societies etc. The increasing ability of genetic techniques to locate specific alleles associated with traits will allow the increased mitigation of undesirable outcomes.

Increased access to advanced imaging such as MRI is opening the door to early genetic disease detection such as Syringomyelia/Caudal Occipital Malformation Syndrome in Cavalier King Charles Spaniels.

5. **What does your organisation see as the key drivers for the future in terms of selective breeding?**

There is an increasingly public awareness of breed related diseases (particularly in the companion animal sector) and their associated welfare issues which may be the catalyst for change. The New Zealand public are increasingly informed, more vocal and have increasing expectations around animal welfare and wellbeing. Similarly public and media attention and the scrutiny of our international trading partners on production sector issues such as bobby calf welfare will increase the industry momentum for more astute use of breeding technology to reduce any animal welfare concerns.

While production traits will continue to be a key driver of selective breeding, the emphasis on resilience and benefits to the breed generally rather than focussing on specific phenotypic traits, is shifting. The NZVA believes that selective breeding must be performed for the overall benefit of the breed or species and take in to account the basic physiological requirements of the animal so as to ensure its ongoing welfare.

The increased collection of genetic information and data is the key to maintaining ongoing genetic progress. This relies also on industry monitoring and reporting abnormal or undesirable genetic outcomes and increasing the acceptance, uptake and informed use of genomic technology by breeders and producers.

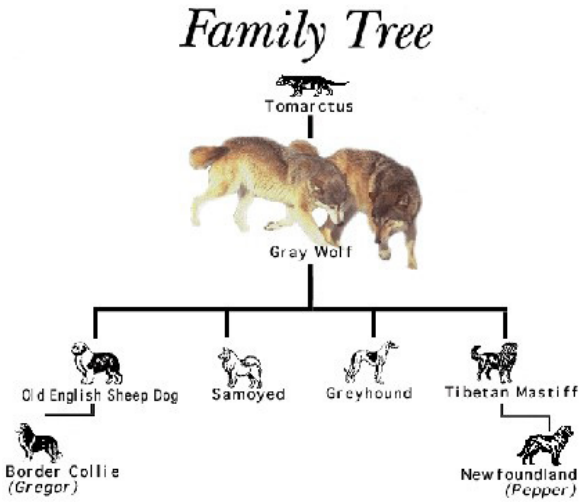
Vets will continue to play a pivotal role across all sectors as trusted and valued professionals whose judgement is based on strong scientific principles and who continue to advocate for the improved welfare of animals in this country.

We thank you for the opportunity to submit.

Yours sincerely

Callum Irvine
Head of Veterinary Services
New Zealand Veterinary Association

Advantages and Disadvantages of Selective Breeding



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The Greyhound

Origin of the Greyhound – Ancestors of sighthounds first appeared among Middle Eastern nomadic peoples. In a movable camp setting, it was common for dogs to follow the camp, eating from its trash. The presence of these dogs was tolerated because of the guard service they provided. But the dogs were regarded as wild and disagreeable, as evidenced by most references to dogs in the Bible, with the exception of Proverbs 30:29-31, which praises greyhounds by name. At some point, a special kind of dog that could hunt along with humans was discovered or bred. These sighthounds were given a special place inside the camp or even inside the tents so that their breeding might be controlled. Some of the oldest known depictions of greyhound-like dogs: in Turkey in temple drawings from 6,000 BC, and in Iran on a 4,000 BC funerary vase.

Ancient Egypt – In Egypt, the ancestors of modern greyhounds were used in hunting and kept as companions. Many Egyptians considered the birth of such a hound second in importance only to the birth of a son. When the pet hound died, the entire family would go into mourning. The favorite hounds of the upper class were

mummified and buried with their owners. The walls of Egyptian tombs often were decorated with images of their hounds. An Egyptian tomb painting from 2200 BC portrays dogs that look very much like the modern greyhound. Many Egyptian pharaohs, including Tutankhamen and Cleopatra, are known to have owned greyhound-type dogs. The Egyptian god Anubis, a hound-type dog, is frequently displayed on murals in the tombs of the Pharaohs.

Ancient Greece – The first breed of dog named in western literature is mentioned in The Odyssey, written by Homer in 800 BC. Odysseus is away from home for 20 years fighting the Trojans and trying to get home against the opposition of the god Poseidon. When he finally returns home, he disguises himself. The only one to recognize him was his sighthound Argus. Art and coins from Greece depict short-haired hounds virtually identical to modern greyhounds, making it fairly certain that the greyhound breed has changed very little since 500 BC.

The Greek gods were often portrayed with greyhounds. A hound often accompanies Hecate, the goddess of wealth. The protector of the hunt, the god Pollux, also is depicted with hounds. One myth tells of how a human named Actaeon came upon the goddess Artemis taking a bath in a river.

She punishes his impropriety by turning him into a stag. He is then hunted down by his own hounds. Depictions of this scene occur many times in Greek and Roman art.

Middle Ages – Greyhounds nearly became extinct during times of famine in the Middle Ages. They were saved by clergymen who protected them and bred them for the nobility. From this point on, they came to be considered the dogs of the aristocracy and the killing of a greyhound was punishable by death. In 1014, laws were established that stated that only the nobility could own greyhounds. Old paintings and tapestries of hunting feasts often include greyhounds.

The term "greyhound may come from the old English "grei-hundr," supposedly "dog hunter" or high order of rank. Another explanation is that it is derived from "gre" or "gradus," meaning "first rank," so that greyhound would mean "first rank among dogs."

Renaissance – Renaissance artists considered the greyhound a worthy subject, depicting greyhounds in a variety of settings from sacred to secular, with an emphasis on the hunt. William Shakespeare (1564-1616) mentioned greyhounds in a number of his plays. In Henry V Henry's speech to his troops just before the Battle of Harfleur compares people to coursing greyhounds.

18th & 19th Centuries – The English Earl of Orford created the first coursing club open to the public in 1776 in Norfolk. Orford crossbred greyhounds with several other breeds, including the bulldog, in pursuit of greyhounds with greater stamina. Despite legends to the contrary, his efforts were unsuccessful and there is no evidence that the bloodlines of these crosses survived. Later attempts to cross greyhounds with Afghans also proved ineffective.

Greyhounds remained a familiar sight among the royalty and nobility of England in the nineteenth century. The husband of Queen Victoria had a pet black and white greyhound, Eos, who appears in many court portraits.

Greyhounds were imported to North America in large numbers from Ireland and England in the mid1800s not to course or race, but to rid farms of a virtual epidemic of jackrabbits. Greyhounds also were used to hunt down coyotes who were killing livestock.

Track Racing – Around 1912, Owen Patrick Smith invented the mechanical lure. He opened the first greyhound track in Emeryville, California. Six years later he owned 25 tracks around the nation, including tracks in Florida, Montana, and Oregon. Florida became the US capital of the sport after dog racing was introduced there in 1922. Greyhound racing became one of the most popular spectator sports in America. Attendance at tracks was nearly 3.5 million in 1992.

Greyhound Racing New Zealand

Greyhound racing as a sport owes much to the hardy and humble hare.

The first hares were brought to New Zealand in 1868 at the behest of Governor Sir George Grey and were released around the country as hunting quarry. However, their prolific breeding quickly made them a pest for farmers who began importing British greyhounds to help control them. Coursing competitions between farms was the inevitable result.

Coursing developed rapidly as a sport. The first clubs were founded in Southland in 1876, and the New Zealand Federation of Coursing Clubs was formed in 1877. The first Waterloo Cup was run near Oamaru in 1879.

Where there's racing, there's usually betting, and bookmakers were on the scene almost from the outset. Generally they were valued for the interest and excitement added by betting. However, a 1908 proposed amendment to the Gaming Act would eventually see them banned from all racecourses and venues.

Banning the bookies set the tone for much of the next 100 years, and the battle for betting has been one of the defining struggles for greyhound racing in New Zealand.

The National Coursing Association was formed in 1908 as a way of uniting and strengthening greyhound racing clubs struggling to get by as public interest in wager-less races waned. When coursing was banned in 1954 the name of the organisation was changed to the New Zealand Greyhound Racing Association.

Despite considerable work by the administration, the sport took another blow in 1949 when the Royal Commission on Gaming refused to award it totalisator betting, saying New Zealand already had enough gambling.

Greyhound racing has always faced an uphill battle. It did not enjoy the best of public perceptions. Many saw live coursing as cruelty to hares, and breeders were often accused of mistreating, doping or brutally culling dogs.

However, in 1970 a boost to respectability came from an unexpected quarter at the time of yet another Royal Commission into betting facilities for greyhound racing.

The Queen and Duke of Edinburgh, who was known for his keen interest in greyhound racing, were due to arrive in New Zealand on the Royal Yacht *Britannia.* The Auckland Club offered the Duke a promising young New Zealand greyhound as a gift. She was gratefully accepted.

Royal Commission, as she was aptly named, would be domiciled in New Zealand and it was proposed that an annual race be held here in the Duke's honour. He immediately offered a trophy and in a few weeks a beautiful solid silver collar arrived from the Royal Jewellers of London.

The Duke of Edinburgh Silver Collar race is still run each year, and remains one of the sport's most coveted titles. It ran for the first time in 1971 at Kumeu, with the largest crowd of spectators ever seen at that time. The Governor General was there, and in following years the race would be attended by assorted dignitaries including prime ministers.

Silver Collar

While those who had presented to the 1970 Royal Commission were confident they had made an excellent case, the popularity of the Silver Collar race almost certainly helped. When the report was finally released greyhound racing was awarded equalisator betting – to commence August 1971.

A feeling of exhilaration rippled through the sport. Greyhound racing still had to go through a

probationary period to prove it had a robust administration and adequate facilities in place before totalisator betting would be granted, but the first major hurdle had been overcome.

Most clubs were run on a mainly voluntary basis, and money was scarce. It took several years for the Association to find or build the new facilities needed, but on course totalisator betting was finally granted in 1978. The first tote meeting, held at Mt Smart Stadium in Auckland on 15 September, was a well-attended despite the rain and a competing Neil Diamond concert.

The true watershed event occurred in 1981, however, when greyhound racing was finally granted access to full off-site totalisator betting and the TAB. This led to a new public profile for greyhounds which so far had only been enjoyed by the thoroughbred and harness codes. Public interest increased further with the advent of Trackside Television in 1992.

As Jeff Lenz, NZGRA Chief Executive at the time, said, "At long last we are considered the equal of our sister codes. A greyhound can now walk into a TAB with its head held high!"

Credit where credit's due: This brief history acknowledges a debt to Sam Fletcher's From a Drag Hare Paddock to Bramich Hare Stadium, from which much information has been sourced.

Educated breeding practices now mean we can confidently identify known risks to our breed when selecting mates.

The known threats to the breed which have been identified in recent years include:

- **Autoimmune Skin Conditions**

One autoimmune disorder fairly common to greyhounds is called the "Pemphigus complex," a group of four skin conditions that occurs when the dog's immune system attacks a normal layer of skin and causes topical ulcers, blisters or weeping lesions to form. Severe cases often trigger secondary skin infections, and affected dogs sometimes suffer from fever, anorexia and depression as well. Two types of lupus occasionally affect greyhounds. Discoid lupus onchodystrophy attacks the toenails, while discoid lupus erythematosus causes crusty lesions to form on the dog's lips and nose.

- **Autoimmune Blood Disorders - Bleeders**

Members of the greyhound breed are somewhat susceptible to immune-mediated hemolytic anemia, which occurs when the immune system kills off the body's own red blood cells. Signs of this disorder often include lethargy, fatigue and weakness, lack of appetite and pale gums or lips. Many dogs with IMHA also suffer from autoimmune thrombocytopenia, a condition that causes the dog's immune system to destroy the platelets and prevent the blood from clotting properly. Greyhounds suffering from this condition often pass blood in the urine, bruise easily and bleed from the mouth or nose. It quite often presents itself after de sexing operations.

- **Autoimmune Eye Conditions - Pannus**

The most common eye disorder in greyhounds is called pannus, a progressive autoimmune eye disease that affects the cornea. According to the Animal Eye Clinic, pannus causes brown pigmentation and redness to form in the white of the dog's eye. This pigmentation gradually leads to vision loss. In addition, connective tissue might grow into the cornea and cause blindness. Vets usually treat this condition with topical steroids combined with prescription eye drops containing cyclosporin.

- **Neuromuscular Autoimmune Disorders**

Acquired myasthenia gravis is a neuromuscular autoimmune condition that sometimes affects greyhounds. This condition causes a breakdown in the communication between muscles and nerves. Depending on the part of the body the disease attacks, symptoms may include muscle weakness in the

eyes, face, limbs or throat. Dogs with neuromuscular autoimmune disorders frequently tire easily and might have difficulty swallowing. Symptoms usually come on quite suddenly, but most dogs experience a spontaneous cure and the prognosis is typically good.

- **Hypothyroidism**

Hypothyroidism is the disease state in humans and animals caused by insufficient production of thyroid hormone by the thyroid gland.

The disease can be inherited or of unknown or uncertain origin. The diagnosis can be complex; the treatment as simple as supplementing a basic essential hormone.

True hypothyroidism probably does not occur in racing greyhounds. Recent work in UK has established that greyhounds have a naturally low TT4 (total thyroxin level) but their free thyroxin levels (FT4) are in the normal range. "Bald Thigh Syndrome" was once thought due to chronic hypothyroidism but is more likely to be due to chronic hyper-adrenocorticism. It does not appear to have any detrimental effect on dogs racing performance.

- **Greyhound Polyneuropathy (PN)**

Greyhound Polyneuropathy is a severe and progressive disease which is found in show lines (USA) of the Greyhound breed. The disease is inherited as an autosomal recessive trait and shows juvenile onset. Recently, a paper describing the work done by Drogemuller et al. was published, which identifies both the gene and the specific mutation responsible for this disease. VetGen has designed a test for this disease based on this work. While the mutation has not been reported in racing dogs, nearly 25% of the show dogs tested were carriers.

- **Hypoxia**

Sudden collapse of a dog at the end of a race. Work currently being undertaken by Dr Steve Karamatic in Australia has failed to identify any single cause for this syndrome. However, certain sires do seem to be over represented in affected progeny. The identity of these sires currently remains highly confidential.

We take this opportunity to thank the Ministry for Primary Industries for allowing Greyhound Racing New Zealand to demonstrate our commitment to the selective breeding practices in our responses documented below:

1. **What does your organisation see as an ethical approach to selective breeding?**

   Identifying and discouraging the breeding with injury or disease prone lines.

   DNA test, identify risks, desexing policies around carriers, care and wellbeing of our brood bitches, Select proven mates, only breed when needed, and desexing of retired/deregistered racing dogs.

   a) Selecting breeding stock both sires and bitches, with temperaments compatible with both racing and life as a pet in retirement.

   b) Breeding from parents that were both sound in terms of physical conformation.

   c) Breeding from parents that either raced successfully or were from a litter where the majority of progeny raced successfully.

   d) Not breeding from parents with closely related bloodlines, i.e .discouraging "line breeding" which is simply a euphemism for "in breeding".

   e) Care with breeding from individuals that suffer severe injury at an early stage in their racing career. A paddock injury may not necessarily indicate an inherent genetic weakness whereas an injury trialing or racing may do.

   f) Improving the total gene pool by importing frozen semen from proven, overseas sires from Australia, USA, UK & Ireland.

2. **What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?**

   Clearly reducing the number of hereditary disorders in the breed, better managing those who do contract a problem.

   a) There has been an increase in some of the known or suspected hereditary conditions in Australasia because these conditions do not necessarily affect an individuals racing career but may adversely affect it in retirement, eg Pannus, cryptorchidism, and nervous or aggressive temperaments. (A recent survey conducted by raceday vets in both NZ & Australia showed an incidence of retained testicles at 17% of male dogs racing in NZ but closer to 30% in Australia. Certain sire lines e.g. Brett Lee are widely regarded as being responsible for this.) On the other hand, known hereditary disorders that plague other breeds are virtually unknown in racing greyhounds, e.g. Hip dysplasia, elbow dysplasia, heart defects, eye defects, hernias, both umbilical & inguinal.

   b) Selective breeding to proven superior sires increases the chances that a higher percentage of litters, and a higher percentage of individuals within those litters will make it to the track & race successfully.

3. **What actions are being taken within your organisation to mitigate any negative effects of selective breeding?**

   a) GRNZ operates a Frozen Semen Bank on behalf of NZ breeders, thus allowing access to proven overseas sires. This not only enlarges the overall gene pool but as in (b) above, reduces "wastage" and improves the chances of individuals making it to the track & racing successfully.

   b) Improvements in GRNZ's database now allows tracking of all pups earbranded & microchipped (must be done by 12 weeks old) from "cradle to grave". The industry now requires reasons for all euthanasias.

4. **What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?**

   a) Genetic testing. Although this is not yet available for most of the heritable conditions affecting greyhounds, the potential is there, and there is the potential for a joint funding effort between GRNZ & Greyhounds Australasia for further research.

b) Cradle to grave tracking will allow identification of breeders and parents with a high failure rate allowing statistical analysis to identify common "risk factors" ie is the problem genetic or management related. (Nature or nurture)

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

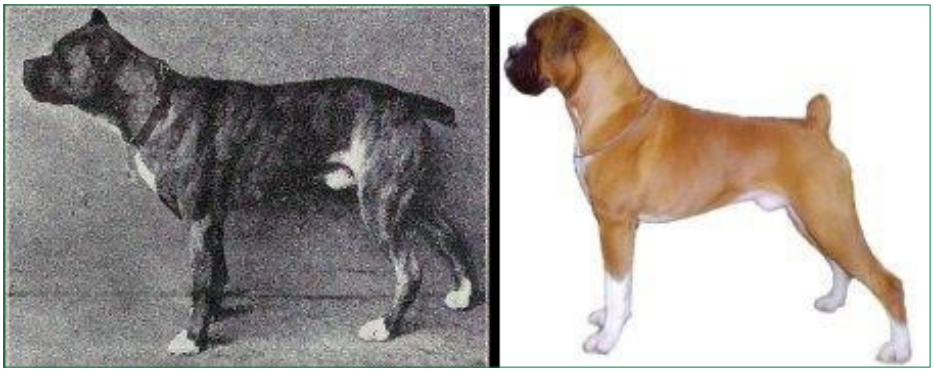
a) Educating breeders to understand the true costs of raising a litter properly. A realistic assessment would be around $2000.00 per pup from birth to racing.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

a) Increasing activism from animal rights groups coincided with the realisation that the code needed a new paradigm. Attitudes such as "breed and weed" or "keep the best and cull the rest" were no longer acceptable. Hence the independent review and the determination of the governing body to implement, as far as possible and as quickly as possible, the recommendations arising from that review.

It is unrealistic to expect any population to be free of genetic diseases but show breeders have intentionally selected for traits which result in diseases. Conformation breeders claim they are improving the breed and yet they are often the cause of these problems. If "improvement" in looks imposes a health burden then it is not a breed improvement.

Greyhound early 1800s Today's example



Boxer 1915 example Today's example

St Bernard 1915 example Today's example

Once a noble working dog, the modern St. Bernard has been oversized, had its faced squished in, and bred to accentuate and exaggerate certain features like the head and bone.

Summary

Each year the industry averages around 137 litters, of these 44 are by natural mating's with local stock, and 93 litters are by AI, using frozen stock from a number of countries (predominantly Australia). 200 years of selective breeding has not changed the breed in any way, today's dogs being indistinguishable from last centuries, meaning we have been breeding athletes, not arbitrarily emphasising arbitrary features deemed "desirable".

Once again – We take this time to thank you for the opportunity in presenting this paper, we are confident that you will agree that our breeding practices, and our focus on maintaining the integrity of the breed is paramount.

As always, our doors are open.

Greg Kerr
Animal Welfare Manager
Greyhound Racing New Zealand.

New Zealand Kennel Club

NZKC Canine Health & Welfare Committee (NAWAC meeting 04.11.14)

Background

Selective breeding of dogs has been used extensively over the centuries to arrive at the many varied breeds we have today. Many of our current breeds date back to the 15th and 16th century and remain today largely unchanged in their phenotype (for example the Bulldog with records dating back to the 5th century)

The Kennel Club (UK) was established in 1847 and was the first Kennel Club internationally. It was at this stage that studbooks were closed and the gene pool available for future generations set. It is from this closed gene pool that the breed types seen today have been developed. Breed standards for each of the breeds were established and although these have been amended over the years, these standards have remained largely unaltered and outline the traits that are desirable to each of the breeds.

Prior to the establishment of now widely available DNA testing to test for autosomal recessive traits, close matings (or test matings) were used to allow breeders to recognize animals that were carriers of specific undesirable genes – (e.g. PRA in the Labrador).

With the availability of DNA testing and other screening methods available to aid in the recognition of genetically affected or carrier individuals within the population breeders no longer have to perform these close matings as a "test" case.

The NZ Kennel Club was established in 1886 and based itself largely on the The Kennel Club which is of course is English. To this day many of our breed standards are based on those of the UK.

What does your organization see as an ethical approach to Selective Breeding?

Discourage as per our rules and regulations close breedings - NZKC Accredited Breeders will not breed from father-daughter, mother-son or brother-sister. Brother-sister is defined as same sire and dam, not necessarily the same litter, but not applying to half-brother/sister.

Encourage breeders to become members of our Accredited Breeders Scheme where health testing of important diseases within breeds is mandatory.

To ensure that the gene pool is maintained within breeds and to not become fixated on single traits at the expense of the gene pool as a whole.

In discussion with Health Committee representatives of the Danish KC in 2012 it was recognized that their prescriptive approach to breeding had resulted in a detrimental effect on the gene pool.

An Accredited Breeder is someone who:

- Encourage the breeding of healthy well-adjusted puppies
- Promote and recognise good breeding practices
- Assist the puppy buying public to find responsible breeders
- Permanently identifies breeding stock by DNA profile and microchip or tattoo.
- Makes use of health screening schemes (as they become available), relevant to their breed, on all breeding stock.
- Ensures their puppies are well socialised before going to their new homes.
- Provides written advice to new owners on feeding, worming, socialization, exercise and future training of their puppy.
- Provides a written record (from a veterinarian) on the immunisation measures taken to date on the puppy.
- Will advise the buyer of any know inherited disorders that the puppy or adult dog may be predisposed to which may cause health welfare problems during the dog's lifetime.

What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

Using widely available DNA testing and applying results to selective breeding has allowed for the reduction and elimination of traits within breeds within a short period of time.

E.g. Canine Leukocyte Deficiency Syndrome (CLAD) in the Irish Setter was recognised in mid 1980's. Applying careful breeding guidelines has allowed this disease to be virtually eliminated within one generation.

Care must be made however that our already small gene pools for many breeds are not further diminished by applying too much selection pressure to these breeds. As mentioned above it has already been recognised that this has occurred in other countries with a deleterious effect on their breeds.

We also have to be aware that many of our breeds can be traced back to a small number of original common sires as at the mid 1800's when stud books were formed – careful use of tools such as the COI will further allow us to monitor our gene pools and ensure that we did not adversely affect this.

The perception by the public that cross bred animals area healthier than pedigree animals has further put pressure on our breeds with many breeders no longer breeding due to a decrease in their market – as we know many of these crossbreds actually exhibit traits worse than their parent breeds with the Labradoodle being the best example where PRA and Hip Dysplasia statistics are worse in this breed than any of the parent breeds.

What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

Establishment of the Accredited Breeders Scheme in 2009/2010. This encourages breeders to identify important diseases within their breeds and then to carry out mandatory testing for these traits to allow informed breeding decisions to be made.

Judges are being encouraged to take into account the health and welfare of dogs when judging to further encourage the breeding of healthy "fit for function" dogs.

For Breeders who have embraced the ACB's scheme we do not allow the use of sires or dams under the age of 12 months. For a bitch there is also a restriction on 2 litters within 18 months.

What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

The success with artificial insemination and the importation of chilled and frozen semen enables breeders to access genetic material from international sources at a realistic cost.

Breeders can apply for permission prior to breeding to perform dual sire matings, which allows breeders to achieve further genetic gain with less matings being required. All resulting puppies must be DNA identified prior to registration.

The advent of affordable and accessible DNA testing to identify carrier animals within a population allows for informed breeding selections to be made and affected animals that may previously been eliminated from gene pool can now be used judiciously within a breeding program – affected to clear individuals producing carrier offspring that can then be bred back to clear individuals to clear a trait.

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

To produce healthy "fit for purpose" individuals that are well adjusted with good temperaments.
To maintain the gene pool of our breeds.
We need to encourage breeders to continue to look internationally to source bloodlines that may not be available in NZ but also to encourage breeders to ensure that any imported genetic material is from health tested individuals.

With the popularity of crossbreds within our community the number of active pedigree breeders is diminishing putting further pressure on the gene pools available to breeders.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

Lessons learnt from Scandinavian countries where a prescriptive approach to breeding has led to a deleterious decrease in the available gene pool should be avoided here in NZ

Careful selection of animals that not only phenotypically meet the breed standard but that are healthy and fit for function needs to be encouraged.

Any future, potential changes to be considered in breed standards need to be considered carefully and take into consideration the underlying health and wellbeing on the individual.

New Zealand Cat Fancy

NEW ZEALAND CAT FANCY INC.
Member of the World Cat Congress

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21st October 2014 BSAC21/10

Marie Guigou
NAWAC Secretary
PO Box 2526
Wellington

Dear Marie

Re: NAWAC – **NZCF Response to questions**

1. **What does your organisation see as an ethical approach to selective breeding?**

   - The NZCF considers it important to identify harmful genetic conditions that occur within breeds or populations and encourage breeders to use available genetic and other tests to reduce or eliminate these.
   - We consider it important to identify unwanted harmful effects from breeding selectively for appearance and ensure that these are countered by our written standards of points (which describes the ideal cat in the particular breed)
   - We believe that when breeding companion animals (such as pedigree cats) breeders should be mindful of health and temperament as well as appearance, when selecting breeding stock

2. **What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?**

   Considerable changes in appearance (and much greater consistency of appearance) have been achieved by selective breeding in many, perhaps most, breeds. In general this has not been associated with any directly negative effects in pedigree cats, with one or two exceptions, for example some (but not all) Persians and Exotics have narrowed or distorted nasal passages which may affect their breathing.

   Generally pedigree cats are more consistent and predictable in temperament as well as appearance, than non pedigree cats (being more likely to be affectionate and people

oriented and less likely to be aggressive or very timid), and this is a reflection of decades of selective breeding. Non pedigree cats have a much wider range of possible temperaments.

An unintended consequence of selective breeding where certain ancestors occur many times in a pedigree, or a particular ancestor appears in most pedigrees, is the spread through a gene pool of harmful genetic conditions, and there are many examples of this worldwide. Eg HCM in Maine Coons– evidence suggests that around 40% of Maine Coons were carriers of one of the genes that contributes to hypertrophic cardiomyopathy at the time when testing was first developed.

Overseas, selective breeding for a particular 'look' in Burmese cats in the United States led to the spread of a severe genetic defect (craniofacial defect) through the breed. Cats that had the desired phenotype were likely to be carriers of the gene, but homozygous cats were born with the severe (fatal) defect. A genetic test has recently been developed that will allow breeders to breed away from this.

Worldwide, using Persian cats as an outcross in the British Shorthair breed (in order to improve the boning and other characteristics of the breed), unintentionally led to the introduction of PKD (polycystic kidney disease) into the British gene pool.

However in some breeds, selective breeding where breeding animals are selected on the basis of being free of a harmful genetic condition has greatly reduced the incidence of that condition. While we do not have figures for the current incidence of PKD (polycystic kidney diseases) in Persians we know it is dramatically lower as the majority of breeders are now breeding with tested, negative breeding stock. In Ragdolls within NZ breeding rules requested by the breeders themselves now do not allow breeders to use cats that carry the HCM mutation to breed with. This in turn has reduced the incidence of the disease in the breed as a whole.

3. **What actions are being taken within your organisation to mitigate any negative effects of selective breeding?**

The NZCF is in the process of developing a breeding policy for each breed, covering recommended testing protocols for harmful genetic conditions. These protocols will be voluntary, unless the breeders endorse a compulsory regime. Incentives will be developed to encourage breeders to follow these guidelines (if they remain voluntary).

The NZCF has also endorsed a Strategic Plan which includes supporting best breeding practices and cat welfare generally.

We have a Breed Standards Advisory Committee, which reviews (among other things) issues around selective breeding and makes recommendations to the Executive Council. For example some breeds which are still in development and have small gene pools have permitted outcross to other breeds in order to maintain a healthy gene pool.

4. **What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?**

The most useful technology for us is DNA testing for harmful conditions which is easily implemented and generally relatively inexpensive. But we don't yet have tests for all the harmful genetic conditions we are aware of.

DNA testing for some traits (such as recessive colours or patterns) is also useful in supporting intelligent selective breeding towards particular goals.

Future developments may see us able to identify many more traits both harmful and beneficial and thus enable selective breeding in favour of some traits (including immune competence) without unwittingly reinforcing other, unwanted traits or conditions.

Sadly artificial insemination which could open up many possibilities, is not available to cat breeders due to the difficulties in humanely collecting semen from males.

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

Education of breeders to maximise beneficial selective breeding especially in regard to eliminating harmful genetic conditions and generally breeding for health and temperament as well as appearance. Development of a positive culture among our members that supports and encourages this.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

The discovery of a hereditary myopathy in Devon Rex (worldwide) led to rules allowing outcrossing to domestic cats to broaden the gene pool in this breed.

General awareness of the risks of repeated inbreeding over generations means that most breeders consider close matings carefully and will mate the progeny of such a mating to an unrelated cat.

Zena Pigden
NZCF Chair

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24 November 2014

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By email to: nawac@mpi.govt.nz

Consultation: Selective Breeding and Animal Welfare - DairyNZ Submission

DairyNZ welcomes the opportunity to provide comments to NAWAC on the animal welfare aspects of selective breeding.

Our interest in this consultation

DairyNZ is the industry good organisation representing New Zealand's dairy farmers. Funded by a levy on milksolids and through government investment, our purpose is to secure and enhance the profitability, sustainability and competitiveness of New Zealand dairy farming. DairyNZ is a partner in the *Strategy for Sustainable Dairy Farming: Making Dairy Farming Work for Everyone,* and one of the 10 themes of this strategy is animal welfare. DairyNZ recognises that animal welfare is a core foundation of dairy farming: healthy animals are productive animals. Furthermore, being able to continue to assure consumers, regulators and the New Zealand public that New Zealand dairy animals are well looked after is important.

DairyNZ has participated in the development of codes of welfare, such as the Code of Welfare for Dairy Cattle and has engaged with the Government in the development of compliance and enforcement plans for animal welfare. We promote industry based tools to support animal welfare objectives, such as an animal welfare component in the "compliance toolkit", which is designed to help dairy farmers meet compliance requirements around health and safety and employment. Against this background we have an active interest in engaging with the Crown on the changes it is proposing to the animal welfare system and legislation.

DairyNZ, through its subsidiary NZ Animal Evaluation Limited, is also responsible for setting the National Breeding Objective (NBO) for dairy cattle. The NBO is expressed via Breeding Worth ($ net farm income per 5 tonne of dry matter) which includes seven traits (milk volume, milk protein, milk fat, fertility, somatic cell score, liveweight and residual survival) known to influence the profitability of dairy cattle.

Responses to the questions posed

1. What does your organisation see as an ethical approach to selective breeding?
   - Focussing on breeding animals that are 'fit for purpose', that is animals that are profitable, well adapted to NZ farming conditions and will be productive without having negative health impacts. This means taking account of not only productive capacity when selecting animals to breed from, but also directly traits such as fertility, somatic cell score and residual survival, and this also includes 'traits other than production' such as temperament and udder quality, and resistance to lameness and mastitis. This is a multi-trait balanced selection process.
   - Finding a use for all animals that are bred in the farming system. All lactating cows will produce a calf each year. During the mating period most farmers will use artificial insemination for the first 4-6 weeks of mating to produce dairy breed calves that will become replacement cows for the herd. In the second half of mating many farmers use natural mating with beef breed bulls to produce calves that can enter the beef industry. Other uses for calves include bull beef (mostly Friesian bulls), live animal export of surplus replacement heifers, and bobby calves. Bobby calves, though shortlived, are used by the meat processing industry. There is very little slaughter, and disposal with no return, of animals in the dairy industry.

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breeds that you work with?
   - The use of the multi-trait, Breeding Worth index, to select dairy cattle has resulted in dairy cattle that are more productive and live longer. In 2002, fertility was introduced into Breeding Worth and this has helped arrest a decline in fertility in the national herd.

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?
   - The dairy industry is using a balanced selection index that includes not only production, but also aspects of animal health and welfare, to ensure that 'fit for purpose' animals are being bred for the industry.
   - Body condition score is being considered as an additional trait for Breeding Worth to ensure cows maintain condition better and so enable body condition score between drying off and calving to be easier to manage.
   - DairyNZ also provides results of gene tests for individual bulls, such as small calf syndrome, so these genetic variants can be considered in mating.
   - A research project is being undertaken, with a range of industry partners, to identify the reasons for the early exit of young stock and dairy cattle from dairy herds so that more targeted genetic and management solutions can be provided for the industry.

4. What technology does your organisation see as being useful in dealing with breeding issues?
   - Genomics enables the identification of genetic variants that can have negative effects on animal health and welfare. Breeding stock can then be screened for these variants and

removed from breeding programmes. This is a particularly useful tool for the evaluation of sires that could be used widely within the industry.

- More comprehensive and accurate phenotypic recording also enables better identification of the genetics underlying animal health and welfare traits. 'Deep phenotyping' has become more commonplace over recent years to enable this matching of genetics and phenotype to occur.

5. What are the most exciting new or emerging breeding technologies for your organisation?
   - The potential to estimate breeding values for lameness, mastitis and facial eczema tolerance is being explored to find out if it would be possible to genetically improve dairy cattle for these traits.

6. What does your organisation see as the key drivers for the future in terms of selective breeding?
   - Drivers to reduce culling rates in the industry, so a focus on cow longevity, and to do this cows need to produce well, have reduced susceptibility to common diseases such as mastitis and lameness, and be fertile, that is get into calf each year.

7. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?
   - Breeding practices within the NZ dairy industry have evolved over time. Focussing only on production as a trait, has in the past, led to reduced fertility. The industry is now very aware that a multi-trait, balanced selection process produces animals that are better overall for the farming system. It should be noted that different farming systems in NZ (eg all pasture, a mix of pasture and supplement, different climatic conditions) have requirements for a different mix of traits and the breeding companies offer a selection of bulls so that farmers can select the cow type that best suits their circumstances.

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SPCA®

SUBMISSION

BY THE

Royal New Zealand Society for the Prevention of Cruelty to Animals Inc

ON

Selective Breeding and Animal Welfare

February 2015

SPCA® Submission

Selective Breeding and Animal Welfare

1. Introduction

The Royal New Zealand Society for the Prevention of Cruelty to Animals (RNZSPCA) is the preeminent animal welfare and advocacy organisation in New Zealand. We have been in existence for 129 years with a supporter base representing many tens of thousands of New Zealanders across the nation.

The organisation includes 47 Animal Welfare Centres across New Zealand and over 90 Inspectors appointed under the Animal Welfare Act 1999.

2.1 Position Statement

The RNZSPCA is opposed to the selective breeding of companion animals which produces adverse effects on their health or quality of life.

Selective breeding often causes changes in bodily form and/or function which are detrimental to the animal's well-being. The practice of breeding in close lineage may lead to unacceptable health and welfare problems.

2. Submission

2.2 What does your organisation see as an ethical approach to selective breeding?

Research clearly shows that many animals experience compromised welfare due to direct and indirect effects of selective breeding practices. These effects are perpetuated from generation to generation and an animal's quality of life can be severely reduced.

An ethical approach is for buyers, breeders, veterinarians, farmers and society at large to embrace and implement any advances and improvements in animal health and welfare in selective breeding practices.

- Breed standards and policies need to be evidence based,
- Breeders need to prioritise the health and welfare of parents and their offspring,
- Only animals whose anatomy and genetic predisposition for ailment or disease, make them likely to produce offspring which will experience a life free from pain and suffering should be bred,
- Only sufficient numbers of these animals should be bred to meet current demand so that each one is able to be homed successfully.

2.3 What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

Negative

Exaggerated anatomical features

- Dogs with very short legs that may be predisposed to disorders of the vertebrae column,
- Fast growing broiler chickens with weak physiological structures which can lead to impaired body function, including difficulty standing and walking and congestive heart failure,
- Brachycephalic canine and feline breeds can often suffer from breathing disorders and blockage of the tear ducts, resulting in other issues.

Inherited disease

- Syringomyelia and mitral valve disease in Cavalier King Charles Spaniels,
- Cancers in Boxers,
- Hypokalemic Myopathy in Burmese cats,
- Polycystic kidney disease in Scottish Fold cats,
- Increased susceptibility to mastitis and reproduction problems in dairy cattle with high milk yields.

Positive

- Ability to reduce welfare issues identified in the production sector by influencing behaviours such as feather pecking in laying hens and tail biting in pigs.

2.4 What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

- Education of the public so they are able to make informed decisions,
- Participation in industry groups, committees and councils.

2.5 What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

- Genetic testing and screening programmes
- Research into the control and diagnosis of genetic diseases
- Regulations and codes of practice

2.6 What does your organisation see as the key drivers for the future in terms of selective breeding?

- Public awareness
- Consumer demand
- Global research outcomes

2.7 What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

N/A

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Aquaculture New Zealand

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Consultation: Selective Breeding and Animal Welfare

Aquaculture New Zealand (AQNZ) is the national organisation representing the interests of the aquaculture sector in New Zealand. It was formed in 2007 as a single voice for the New Zealand aquaculture sector to protect the current industry, while enhancing its profitability and providing leadership to facilitate transformational growth. Our aim is to see the New Zealand aquaculture sector recognised within New Zealand and around the world as producing healthy, high quality, environmentally sustainable aquaculture products. Primarily funded through an industry levy, the organisation's chief role is the implementation of the industry strategy and ten point plan for the sector to grow to earn $1billion annually by 2025.

You have requested information related to a number of areas around selective breeding of fish for farming. Aquaculture New Zealand can respond on behalf of the salmon farming sector, however there are other organisations involved in breeding other species of finfish, including kingfish, hapuku, whitebait, eel, carp, etc. that we cannot speak on behalf of.

In response to your specific enquiries we offer the following information:

Q1. What does your organisation see as an ethical approach to selective breeding?

The industry has set out to farm salmon in an environmentally and socially responsible manner. This ethos forms part of the New Zealand quality story around farmed King salmon. The industry therefore is proactive in ensuring that selective breeding programmes are effective and are consistent with world's best practice. This commitment includes planning and programme management by professional geneticists to always ensure a genetic effective population of sufficient size, managing in-breeding potential, avoiding potential negative traits through good breeding design and delivering improving economically beneficial production and harvest quality traits.

Q2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

The purpose of selective breeding in the salmon industry is to produce a fish that is identical to, or better than, the conformation and appearance of a wild salmon, albeit with improved growth and flesh quality characteristics. There is no pressure to select for exaggerated physical characteristics; indeed it is the opposite that is sought, i.e. a nature identical animal.

Natural variation and distribution of phenotype is of course expected within family lines and even individuals within a selective breeding programme, and any naturally poorer performing individuals would be selected against in the next round, thus adverse characteristics are actively excluded from the programme.

Positive aspects from selective breeding include faster or more efficient growth rates (neutral for the fish held in a controlled environment with access to sufficient high quality feed, positive for the farmer and for the environment), more robust animals (positive for the fish and the farmer) and improved quality at harvest (neutral for the fish, positive for the farmer).

Q3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

Breeding programmes are professionally designed and operated, broodstock and offspring are actively screened for any adverse characteristics and then excluded from subsequent breeding. Fish populations are under close scrutiny throughout their production cycle thus assisting to identify any positive or negative characteristics.

Q4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

The industry uses a range of technologies to ensure the highest quality and performing fish (harvest quality and natural physiology) are selected for the breeding programme. This includes radiography (to exclude skeletal malformations), near infrared spectrometry (for fillet quality measures) and industry is exploring the use of genomics as a tool to assist selective breeding.

Q5. What does your organisation see as the key drivers for the future in terms of selective breeding?

The industry is seeking to improve growth rate (better production returns from available water space) and feed conversion efficiency (to reduce environmental footprint and mitigate against feed cost increases), increased harvest size delivered within appropriate length:weight proportions and continued improvements in resilience of fish.

Q6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

The industry is very clear that they have not experienced anything in their history of selective breeding that has made them alter markedly from their current selective breeding strategies, which are after all professionally designed and managed. Industry complements breeding choices through continual developments in husbandry techniques which have the capacity to deliver just as much stock improvement as selective breeding.

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Aquaculture New Zealand

Aviagen

Consultation Selective Breeding and Animal Welfare

National Animal Welfare Advisory Committee New Zealand

1. What does your organisation see as an ethical approach to selective breeding?
   - Aviagen see it as their role to develop the appropriate birds for appropriate production systems with the latest management information, while treating the birds with care and respect, ensuring to improve health, welfare and productivity as well as environmental impact and satisfying global food demand at the same time. The breeding companies do this via balanced breeding from a large gene pool.
   - Aviagen has a long history in selection for welfare improvement, i.e. leg health has been included in the breeding programme since the 1970s. Targets for all traits in the breeding goal are defined upon consideration and analysis of customer and society feedback, global and regional poultry market situation, and global and regional macroeconomic environment.
   - The basis of the Aviagen breeding programmes is their genetic diversity, both between and within lines. It is their major asset (e.g. Olori and Avendaño, 2014).
   - Furthermore, Aviagen actively provide technical support and develop detailed management information (see www.aviagen.com tech center).

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?
   - In any breeding programme, so also in broiler and turkey breeding, it is very important to improve many traits at the same time, i.e. to improve both the bird´s productivity as its support system at the same time. Forty years ago, the possibilities of including many traits in the breeding programme were not available, as it was still difficult to improve antagonistic traits simultaneously.
   - Aviagen can now simultaneously improve antagonistic traits (traits which are unfavourable correlated, like robustness traits and production or efficiency traits) as part of its balanced breeding programme.
   - Since the 1970s Aviagen have gradually included more and more traits in the breeding programme, in particular in the area of health and welfare (Neeteson-van Nieuwenhoven et al, 2013). This has been recognised by independent authorities like the Farm Animal Welfare Committee (FAWC, 2012), and the European Union DG Sanco report on broiler breeding (Hiemstra & Ten Napel, 2013), and is confirmed via public data (e.g. Canadian Food Inspection Agency, Agristats) and a growing number of peer reviewed scientific publications (e.g. Fleming et al, 2007; Kapell et al, 2012 a, b, Hill et al, 2014).
   - As from the start, Aviagen has selected its birds in group circumstances, thus ensuring that the birds do well in a group environment and integrating group aspects in a natural way in the populations.
   - Due to advances in poultry breeding, poultry meat has a very low environmental impact (e.g. Williams et al, 2006; Leinonen et al, 2012; Neeteson-van Nieuwenhoven et al, 2013).

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?
   - Kapell et al (2012b) show the simultaneous improvement of leg health and growth rate over 25 years in the Aviagen breeding programme. The paper of Kapell et al (212a) on breeding for Footpad Dermatitis (FPD) shows how we achieve improvements in sensitivity for FPD in our breeding programme. The prevalence of FPD has reduced by 2% per year since the trait was included in our breeding programme (Hiemstra & Ten Napel, 2013).
   - Breeding is not taking place to mitigate negative effects, but to improve the whole bird.
   - We have applied balanced breeding, and extended the balance and depth of the breeding programme in

step with the technological and scientific possibilities that we initiated and got access to. For example:

- All birds are individually identified, and family member information is gathered and taken into account
- Many measurements are taken on every bird in the pedigree programme by experienced members of our selection teams. Our selection teams are benchmarked continuously.
- We develop new traits continuously, e.g. on leg health, gut health, behaviour, cardiovascular system, walking ability, feed conversion rate, meat quality, reproductive capacities of males and females, growth rate.
- Powerful programmes have been developed to manage the enormous amounts of data.
- Birds are selected in clean environments so that they are free of a number of diseases, and are able to express their full potential.
- Siblings of the pedigree birds are raised in commercial environments to improve robustness.
- In order to improve welfare, health, production and environmental impact simultaneously, it is crucial to manage antagonistic traits and select birds that e.g. have better legs and better feed conversion. This is not done for two, but for tens of traits, including production, health, welfare, reproduction, etc.
- Management advice is constantly being adapted to the latest circumstances in the world and the changes in the crossbreeds.

4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?
   There is not one technology, we work with as many technologies as is useful to achieve robust, diverse, productive and balanced populations. These include pulse oximeter (to assess cardiovascular function), lixiscope (real-time X-Ray to assess subclinical incidence of Tibial Dyschondroplasia), feed stations to record individual feed intake throughout the life of the bird, life time water intake systems.

   We have been investing in genomics and are the first poultry breeding company applying genomics as part of its selection programme (e.g. Avendaño et al, 2010; Kranis et al, 2013). Genomics is an additional tool next to the other tools we have developed and implemented. The use of genomics information further strengthens our tradition of incorporating R&D for the improvement of our broiler breeds - a stronger, fitter and healthier bird which is able to resist disease and deliver predictable performance wherever it is placed. We can now see at the genetic sequence level the unique qualities of each bird. This is especially important for attributes for which there is a limited amount of individual record of performance at the time of selection, like sex-limited traits.

   For instance, in the past we have been able to make a prediction of the genetic potential for egg production or hatchability of a male selection candidate based on the qualities of its family, but without individual records it is not possible to differentiate birds from the same male and female parent. With genomics we can now see exactly what the genetic configuration of each bird is and what has been inherited from its parents. By utilizing this unique insight from our birds, we can make even more accurate selection decisions in order to improve all aspects of the bird's performance at every generation (http://en.aviagen.com/aviagen-includes-genomics-information-for-the-on-going-improvement-of-its-broiler-products/).

5. What does your organisation see as the key drivers for the future in terms of selective breeding?
   As a poultry breeding company we have the responsibility to ensure that healthy, responsibly bred chickens and turkeys are available globally for meat production. Key items are:
   - Global food security
   - Environmental impact
   - Lean, healthy meat
   - Affordable meat
   - Bird health and food safety
   - Bird welfare and bridging gap between bird welfare and perception of welfare

- Have a wide portfolio of products ranging from standard to slow growth
- Answering demand for diversification of breeds, e.g. speciality breeds
- Ensuring diversity between and within lines to provide chicken and turkey breeds for any foreseeable future.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

   As poultry breeders, we have been listening carefully to the questions and concerns from both our customers and society. Then we have been working towards solutions and answers, whether they are in the area of management (e.g. Van Emous et al, 2013; De Jong and Van Harn, 2012) or in the area of genetics.

   In recent years we have enhanced communication with society, and publication of our achievements over time in peer reviewed journal articles, as we realised that the perception of poultry breeding including with many scientists and policy makers, reflected the situation of poultry breeding ten or twenty years ago. We realise we have a responsibility with regard to transparency on the work we do, e.g. via peer reviewed journal articles. This is now part of our corporate responsibility.

   We have a proactive attitude toward expanding the breeding goal to select for wider aspects of the bird. At every moment in time, we are working on improving the tools and traits we have, the ways we gather data, and the ways we improve our lines and breeds. An interesting improvement was the introduction of the ´sib-test´: the housing of siblings of the selection candidates to measure the robustness of the chicken or turkey families in commercial environments.

   Another interesting addition was the development and implementation of life-time FCR, which enabled the measurement of feed intake in a group environment. It also shown that the feeding behaviour is common across broilers, turkeys, ducks, cattle, pigs, dolphins and rats (e.g. Howie et al, 2009, 2011; Tolkamp et al, 2011).

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Cobb

Response to Questions from NAWAC (New Zealand)

1. What does your organisation see as an ethical approach to selective breeding?

For Cobb, an ethical approach to selective breeding has to be a sustainable approach. This requires quality input from animal breeders, scientists, welfare organizations, ethicists, sociologists, economists, governments, and last, but absolutely not least, the customer. Our company utilizes an external welfare advisory panel. Cobb's external animal welfare advisory panel is a select group of experts in animal welfare. Members include: welfare officers from leading integrated poultry companies and poultry science researchers in genetics, behavior and breeding. With the diversity of the group, the panel serves as a 'think tank' to help Cobb prioritize welfare-related research, evaluate innovative ways to address welfare concerns, improve communication about poultry welfare, and objectively assess best practice animal welfare guidelines & standards.

The goal of the panel is: to provide independent expertise and share knowledge to support the development of science-based, global best practice animal welfare guidelines and internal practices to improve and/or enhance poultry care, handling and well-being. Encourage sound research to improve the health and well-being of meat-type chickens.

We use feedback from a range of sources to decide how we adjust our breeding program and to determine where and how we should invest in research to make sure that we are able to supply our customers the right bird for the future. No single group drives the balance in our breeding program. Our research is focused on improving bird health and wellbeing, efficiency, the environment, food safety, product quality and genetic diversity.

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

Improvements have been made in bird health and wellbeing, performance, and environmental impact. Reduction in environmental impact as a result of improvements in efficiency is equal to 550 metric tons less manure produced each year for a complex raising 1 million broilers per week to 2.27 kg. Any negative effects to bird welfare or behavior are addressed as they are identified.

Example: There are some meat quality traits that can be expressed under fast growing industry conditions when they are raised to heavy weights. We are focusing on both internal and external research to identify management solutions, expression models, and selection technologies/techniques to improve the muscle fiber quality as needed.

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

The foundation of our selection process is phenotypic evaluations of every individual bird at multiple points in their life, with the primary evaluation occurring at the appropriate market weight for each line. This process allows us to identify these effects. As indicated in the example from Q2 above – We then invest in identification of management solutions, expression models, and selection technologies/techniques. Depending upon the issue that arises, we may also introduce a different line into the product pipeline that changes the field performance of the trait in question. Cobb maintains a stable of genetics that ranges from very rustic colored lines with various strengths and immunity profiles, to more modern broiler strains that are used in the industry today. We also partner with other companies to address customer needs from time to time (example – SASSO in France and Hendrix Genetics in the Netherlands).

4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

We develop a range of proprietary technologies as needs arise. We also take advantage of advancements in human medical research and technologies to better understand and measure the health and performance of poultry. In addition, advances in understanding of human and animal genomes provides the opportunity to use DNA marker-assisted selection programs to drive the improvement for disease resistance and meat quality characteristics that were in the past, difficult or impractical in a bio-secure pedigree program. We are also excited about the potential use of cross-bred phenotype analysis under a range of conditions, and the use of marker assisted selection to make improvements in our purelines based upon this new information.

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

We believe the key drivers will be:

a) Customer/Consumer requirements – example from U.S.: Chick-Fil-A announces that their chicken supply will be anti-biotic free in 5 years

a) Regulatory pressure – example from Germany: Focus in Lower Saxony on FPD and stocking density

a) Competitive pressure – new offerings from the competition that may have a different trait balance

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

1. We have learned that selecting our lines in the right environment is critical to selecting the right genetic stock. A challenge that all breeders face is the ever-changing customer broiler environment with market weights changing over time, feed ingredients changing, and supplement or antibiotic use being regulated on a country by country basis. We have learned that our breeding program has to be focused on selecting birds that can perform in a wide range of environments, with "environment" including all the management and input parameters.
2. As good as our program may be today, we can always make it better. We are constantly looking for new research partners to help us develop better techniques or technologies, and we are constantly looking at feedback to make sure that we are responding appropriately.

Hy-line International

Consultation Selective Breeding and Animal Welfare of National Animal Welfare Advisory Committee New Zealand

Response from Hy-Line International

1. What does your organisation see as an ethical approach to selective breeding?
   Hy-Line International is committed to an ongoing research program designed to maximize potential from each flock.
   Utilizing one of the world's most extensive gene pools, Hy-Line researchers employ the latest scientific and statistical methods to pursue genetic breakthroughs in poultry breeding.
   Hy-Line has a long history in selection for welfare improvement, for example resistance to Mareks disease.
   Breeding targets for all traits in the breeding program are chosen upon consideration and analysis of customer and society feedback.
   We provide technical support and develop detailed management information.

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?
   Experience has proven that nature's genetic balance is inherently delicate and that improvement in one trait must be made with careful consideration for the effect it will have on other desirable characteristics. With this in mind, Hy-Line geneticists utilize exacting research procedures to preserve the unique genetic balance, while continuously improving performance traits of Hy-Line stock
   In any breeding programme, it is very important to improve many traits at the same time, first identify the trait we want to change. Can we measure the trait directly (Liveability) or by indirect measures (fear) can individual phenotypes be collected? Or will the trait be measured in sib or half sib groups? Evaluation must be manageable in large populations 10,000 plus per generation
   We simultaneously improve many traits across the range we are evaluating, taking care to ensure that positive movements in one trait are not adversely countered by negative in another, an example of this could be the birds inquisitive nature which is required to find feed or a nest box verses aggression which could lead to injurious pecking.

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?
   As with most Commercial Layer breeders we use crossbred testing. Group evaluation to provide data on liveability, measure behavioural traits in group environment, evaluate genotype x environment interactions.
   Birds must be adaptable to cage or floor production systems, group environment are used to evaluate low dominance drive, nest utilization selection, social behaviour, feather cover and reduced beak trimming needs.
   All birds are individually identified, and family member information is gathered and taken into account, this information is gathered from 3 sources,

Field testing of sire coded crossbred daughter these are exposed to commercial conditions in multiple bird cages, on multiple farms in multiple countries
On research farms using pedigree pure line daughters kept in research conditions in single bird cages and in limited locations in Iowa.
Using DNA selection utilising Hy-Line's Molecular biology laboratory which opened in 1996 this allows DNA – based approaches to improvement of selection, using PCR based technologies, including Marker Assisted Selection, using both Microsatellite markers and SNP markers and has now evolved into the utilization of genomics to improve accuracy of selection at the DNA level.

There is a continual review of the traits used for selection to ensure the breeding program meets the challenges of the global egg industry.

4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

Hy-Line's program of genetic improvement will continue to be based on tried and proven methods, which have stood the test of time and have brought the company to a position of industry leadership. New techniques, utilizing genetic markers for Genomics which has added an extra increment of progress, assuring ever improving Hy-Line products.

Hy-Line's progressing research program guarantees increased egg production, greater disease resistance, improved egg quality and superior liveability, with birds which adapt to multiple different production environments. All traits that assure our customers of even greater benefit from Hy-Line layers in the future.

We have been investing in genomics and are the first layer breeding company applying genomics as part of its selection programme. Genomics is an additional tool next to the other tools we have developed and implemented. The use of genomics information further strengthens our tradition of incorporating R&D for the improvement of our breeds; we can now see at the genetic sequence level the unique qualities of each bird. This is especially important for attributes for which there is a limited amount of individual record of performance at the time of selection, like sex-limited traits. For instance, in the past we have been able to make a prediction of the genetic potential for egg production or hatchability of a male selection candidate based on the qualities of its family, but without individual records it is not possible to differentiate birds from the same male and female parent. With genomics we can now see exactly what the genetic configuration of each bird is and what has been inherited from its parents. By utilizing this unique insight from our birds, we can make even more accurate selection decisions in order to improve all aspects of the bird's performance at every generation

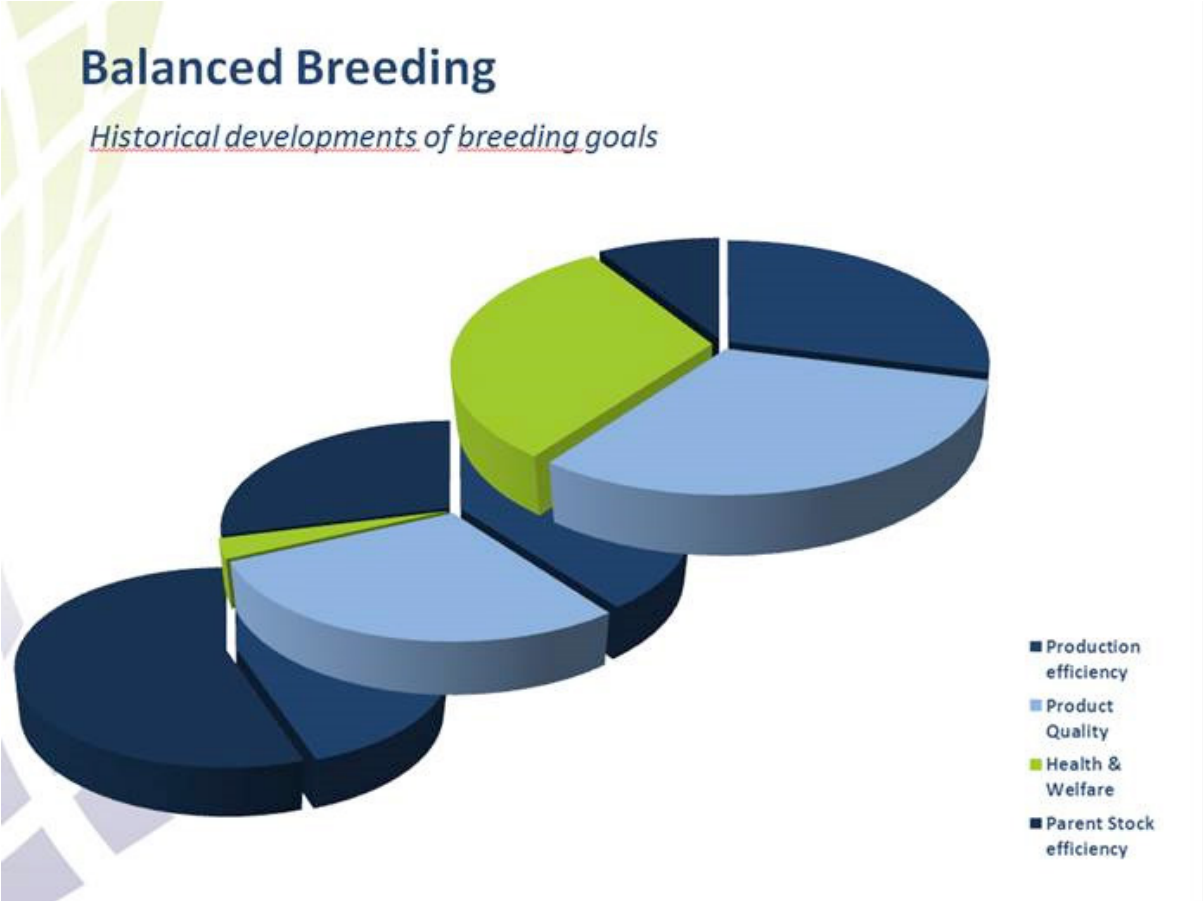
5. What does your organisation see as the key drivers for the future in terms of selective breeding?
   As an egg layer breeding company we have the responsibility to ensure that healthy, responsibly bred hens are available for a growing world population.
   Key drivers are:
   Liveability
   Egg Production
   Persistency of Lay
   Feed Conversion
   Temperament
   Nesting Behaviour
   Sexual Maturity
   Body Weight
   Egg Quality
   Egg Weight
   Shell Colour
   Albumen Height
   Freedom from Blood & Meat Spots
   Animal Well Being will continue to have a significant selection emphasis along with production, egg quality, efficiency and environmental-impact traits.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?
   This increased emphasis in breeding programs on Animal Well Being Traits is consumer driven, we are responding to these demands with the tools and technologies currently on hand. We have been listening carefully to the questions and concerns from both our customers and society.

ISA (Hendrix Genetics)

1. What does your organisation see as an ethical approach to selective breeding?

The important start of selective breeding are the breeding goals, which changed a lot over the decades. Please see the sheet below. In the "60 ties only production efficiency and after 2000 al lot of focus on health, welfare and product quality traits.



Over the years the company takes more breeding goals into account, especially in regard to animal welfare and sustainability. The important word is Balanced Breeding.

Secondly the company works according to the European Code: EFABAR. This code of good practice for farm animal breeding and reproduction organisations (code EFABAR) is implemented in ISA a Hendrix Genetics company. http://www.effab.org/CODEEFABAR.aspx

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

The main goal and positive point is that ISA is producing the genetic sources for first quality food for the world, where more and more protein is required. Because of the genetic improvement the efficiency of this production is improving. (egg output per hen housed, Feed Conversion, egg quality). A very important selection criteria is liveability which has become more important since the ban on cages in EU. ISA is breeding for traits where

layers are more adapted and performing better in alternative housing systems. Besides, ISA is breeding on laying persistency in longer cycles which makes the egg value chain much more sustainable.

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

A basic part of the selective breeding is the field tests. Before new generations are used in the selective breeding, cross bred daughters are tested in the field. Only the best families (without negative effects) are being used in the reproduction of the new generations, and consequently in the reproduction pyramid of grand parent stock and parent stock. As said before, defining the right breeding goals and balanced selection is key to avoid negative effects.

4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

The basic part of breeding is the accurate measurements and sophisticated breeding value estimation. Breeding IT and software together with state of the art facilities is essential to select in a balanced way the best animals for the future.

Currently the most exciting new technology is the Genomic Selection. Hendrix Genetics developed with several Universities a Chicken DNA Chip with 60.000 genetic markers. This is an exciting tool to predict genomic breeding values based on DNA information of the chickens.

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

The key drivers are the requirements of retail/consumers and society. This is in the area of animal welfare, first quality food and sustainability.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

Key is to listen well to signals from the customers and the people in the total egg value chain.

Federated Farmers

1. EXECUTIVE SUMMARY

Federated Farmers welcomes the opportunity to provide comment on selective breeding and animal welfare, while noting that this is an area in which industry good organisations – such as Beef + Lamb New Zealand and DairyNZ – have substantial scientific expertise.

The Federation acknowledges that the current success of the pastoral sector has been built, in part, as a result of the substantial efforts of farmers and scientists over many years in the area of selective breeding. These advances notwithstanding, the Federation recognises that proper care and attention must be given to ensuring that animal welfare issues are taken into account when animals are bred for specific traits.

The Federation's comments – from several of the organisation's sector groups - are provided below for NAWAC's consideration.

2. BACKGROUND

2.1 This information is provided in accordance with the request for feedback, by the National Animal Welfare Advisory Committee (NAWAC) in a 27 January 2015 e-mail from the NAWAC Secretary to comment on matters relating to the welfare effect of selective breeding.

3. SECTOR COMMENTS ON SELECTIVE BREEDING AND ANIMAL WELFARE

3.1 The Goats Industry Group

3.1.1 Background.

The goat industry is made up of angora goats that produce mohair, Boer goats for meat and dairy goats. There are also feral goats that make up the bulk of the goat meat industry but they are not "farmed"

The dairy goat industry is flourishing and they will respond separately on this issue. The angora and Boer goat industry suffer from low numbers – in part a hangover from the 1980's when many people were adversely affected as a result of speculative investment in animal values rather than productive values.

Mohair prices and demand are good but there is not enough fibre being produced and the industry is shrinking. Angora goats have a reputation of being difficult to farm and the majority of goats are on small lifestyle blocks which exacerbate the worm and feet problems. Angora goats perform much better in drier environments.

Boer goats have issues with processing companies not being able to offer them premiums for their superior carcass conformation due to lack of numbers and the challenging logistics around organising goat kills.

The challenge is to grow the industry and selective breeding make offer opportunities to make goats easier to farm in the future as there is demand for both fibre, meat and milk.

3.1.2 What does your organisation see as an ethical approach to selective breeding?

Conform to the relevant codes of animal welfare.

3.1.3 What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

The positive effects include:

- Selecting for resistance to foot problems (scald and foot-rot). In particular the mohair industry has carried work for over ten years with a buck group breeding scheme with different animals from throughout New Zealand brought together and then reared on one farm and selected for their resistance to scald and foot-rot. The weight of fibre and length of the staple was also measured.
- In addition, a recent initiative of the mohair group has been the use of CARLA saliva testing to select for resistance to worms which is a major issue for the goat industry.
- Drench usage in goats is a major hurdle for the industry as many drench companies do not have licensed products for use in goats. There is also a perception/reality that goats are more prone to drench resistance which makes people reluctant to farm them and consequently hinders the growth of the goat industry.

A negative effect is that selecting for a dramatic increase in fibre weight can be detrimental to the frame size of the animal.

The introduction of the African genetics over the years has led to a decrease in twinning rate in some instances.

3.1.4 What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

Not applicable.

3.1.5 What technology does your organisation see as being useful in dealing with breeding issues?

- Gene markers have the potential to help the goat industry make progress with feet, worm and survival traits.
- Fleece testing technology needs to become commercially viable to enable it to be used as a selection tool.

3.1.6 What are the most exciting new or emerging breeding technologies for your organisation

- Gene markers. The equivalent of SIL in the goat industry is needed to make progress.
- Sexed semen especially for the dairy goat industry to avoid the use of having to cull young male animals
- A lack of blood lines in the NZ angora industry is inhibiting genetic progress. Several breeders over the past few years have imported live animals from Australia and these have had a big impact on the fleece performance of the existing NZ animals. The cost of importation is also a major barrier to large numbers of animals being imported.
- There are issues around semen importation from Australia because the protocol for collection means that the buck has to be quarantined which owners are reluctant to do.

- The cost of inseminating does in NZ is also very expensive and the success rate is 50–60%.

3.1.7 What does your organisation see as the key drivers for the future in terms of selective breeding?

Advances are sought in the following areas:

- Feet.
- Worms.
- Fleece weight.
- Farmability-survival, open face.
- Fertility.
- Carcass Conformation
- Meat yield.

3.1.8 What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

As above.

3.2.1 The Meat & Fibre Industry Group

3.2.1 What does your organisation see as an ethical approach to selective breeding?

- To maintain structural correctness, conformation and constitution at all times.
- To use objective breeding tools focusing on production for the environments in which we farm

3.2.2 What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

- Positive effects include progress and retention of acceptable progeny. On the negative side the outcome is to cull and move on.
- Selective breeding using objective tools rather than just visual selection has made balanced selection across all traits including those you can not visually see much easier. An example is selecting big magnificent looking bulls – resulting in bigger faster growing cattle but not taking into account the size of the calves and the stress that places on cows and heifers at calving. With the use of Breedplan in cattle and SIL in sheep we can select for a range of traits (even antagonistic traits). The use of indexes (weighted balance of traits focusing on performance and production for a specific farming scenario or environment with the end consumer in mind) helps maintain genetic progress without the negative effects or animal welfare collateral damage. If a farmer uses performance information (EBVs or indexes from SIL or Breedplan) they will improve their flock or herds performance in their environment. This is an objective selection pressure that is beneficial

for animal welfare and the production and profitability of the farm business.

- Progress using genetic tools mentioned above can be very fast. The need to adapt our farming practises, especially the way we feed our stock needs to be considered. There is no point in having a cattle beast that can grow at 1.5kg per day if we don't feed it properly. Also we need to improve other aspects of farm production alongside the improvement in genetics. Ie improving the forages which animals eat.
- It is noted that it can be dangerous to focus on a single trait that overrides the consideration of other traits. For example, in the dairy industry using overseas Holstein genetics which have been only selected for milk production. In New Zealand the bigger picture is considered hence the development of the Kiwi cross. It is very difficult in the sheep and beef industry to find examples where we focus on breeding for one trait causing detrimental animal welfare effects.

3.2.3 What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

Inherent problems are generally dealt with by culling.

3.2.4 What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

- Being able to measure progress in terms of growth, yield, fat make up via CAT scan.
- In future – genetic manipulation (imagine a Merino with Romney feet), may be able to identify exactly what each gene is capable of.

3.2.5 What does your organisation see as the key drivers for the future in terms of selective breeding?

- Individual performance improvement by paying attention to basics.
- Good recording systems and indexes so the value of different traits can be balanced and considered in relation to the environment and market.
- Continual improvement in the understanding of various genes.

3.2.6 What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

- 1950's–1960's – sheep too short, too fat, poor milking and fertility.
- 1970's–1980's – sheep bred with length, especially loin length which led to ease of lambing, hence better percentages.
- 1990's – large amount of crossing – some good some bad. Exotic breeds ie Finnish Landrace, East Friesian increased fertility and milk but lacked in constitution and bone structure.
- 2000 onward – back to basics approach eg. breeds that emerged 500 + years ago are

still at the fore today. These include the Romney, Cheviot & Border Leicester dual purpose breeds and the Southdown from which all Terminal sire breeds were derived from. Also the imported Texel has been crossed with almost every breed of sheep in NZ.

- Cattle being breed for low birth weights and high growth rates, to minimise impact on the cow/heifer at calving but still allow for good growth and production. No point in having very fast growing cattle if they are huge at birth and cause damage at calving.
- It is noted that nature will determine exactly where and how far we can go in breeding animals. Those breeds that have a long history demonstrate that they have stood the test of time and will be around for a long time. Nature does the bulk of the culling. Concerns regarding structural soundness, conformation and constitution of many cows that have been bred to produce milk – dairy cows' life spans should be longer than they currently are.

3.3. The Dairy Industry Group

3.3.1 The dairy industry is one that has benefitted immensely from advances in production arising from selective breeding. It is acknowledged that, rarely, adverse outcomes can arise – such as was the case with hot, hairy and dwarf cows – and that when this occurs any adverse animal welfare issues need to be managed appropriately and the lessons learnt so that situation does not recur.

Beef and Lamb New Zealand

1. What does your organisation see as an ethical approach to selective breeding?

   B+LNZ Genetics consider the following factors as being important for an ethical approach to selective breeding:

   - Maintain the high levels of genetic diversity seen internationally in sheep and beef cattle
   - Considering the fitness of the whole animal in the environment in which will be farmed in. Many of the unintended negative effects of genetic selection have come about because of selection for a very limited number of traits
   - Comprehensive research programmes for new traits in selective breeding programmes, which have formal approval from animal ethics committees. Development of commercial measurement protocols that take into consideration animal welfare
   - Control of inbreeding which has led to the build-up of deleterious recessive genes and inherited diseases in the past

2. What effects, both positive and negative, of selective breeding are you aware of within the species or breed(s) that you work with?

   Significant improvements in animal health have come about from selection for resistance to diseases. For example, facial Eczema (FE) is a disease prevalent in the northern North Island caused by a fungal toxin which is produced in warm moist conditions. Sheep exposed to the toxin display skin reddening, swelling and photosensitisation externally, liver damage internally, and in severe cases results in death. The condition can be treated with zinc boluses, but significant genetic progress has been made in genetic selection for resistance to the toxin, such that there are breeders flocks that can tolerate high levels of natural toxin challenge without the need to treat animals. FE outbreaks are extending south as climate change brings warmer temperatures so FE resistance will be increasing important in the future.

   Other health traits where positive animal welfare benefits have been achieved include selection for resistance to internal parasites, and in single the single gene disorder micropthalmia (small eyes resulting in blindness). Use of polled beef breeds reduced the need for disbudding or removal of horns.

   Negative effects of selective breeding in sheep and beef in New Zealand would mostly be from moving past optimal levels for individual traits. For example, sheep reproduction has been dramatically increased through genetic selection as noted in the introductory remarks to this paper. While the national average of lambs weaned per 100 ewes is around 124, there are flocks that have much higher rates than this. As reproduction rates increase, the number of multiple births (twins, triples, quads) increases and average birth weight falls. Smaller lambs tend to have poorer lamb survival in cold weather (although there are also issues with large lambs) so neonatal death rates can increase if reproduction rates are increased beyond what the farm can reasonable sustain. However, farmers can also select for improved lamb survival, and most farmers tend to have a maximum reproductive rate they believe to be sustainable on their property and will not continue selection for increased reproduction beyond that level.

   Similarly, there has been considerable selection for increased growth rates and carcass leanness in sheep. There is anecdotal evidence that the selection for leanness in slaughter animals has produced breeding ewes that have lower fat reserves, which are needed on harder country during times when feed supply is restricted (e.g. during a storm in winter). This is being investigated, and work is underway investigating increasing fatness in lamb carcasses to improve eating quality.

3. What actions are being taken within your organisation to mitigate any negative effects of selective breeding?

   A substantial proportion of sheep and beef animals in New Zealand are farmed in hill and hard-hill environments. B+LNZ Genetics is focusing on breeding animals that are fit for purpose in the environments that they are farmed in. For many traits under selection, there are optimum levels of performance that can be maintained in any given environment, and over which performance declines in that trait or in other correlated traits. Selection indexes are used to weight the contribution each trait has in the breeding programme. The weightings that a given trait has in a lowland environment may well be different to the weighting it would receive for a hill environment. B+LNZ Genetics is undertaking research to develop suitable indexes for a range of farming environments. These indexes take a wide view of animal performance including growth, reproduction, health and disease traits. Many of the negative effects of selective breeding have come from taking a narrow view of performance based on very few traits.

   Another part of the B+LNZ programme is to determine the extent of so called genotype by environment interactions in the sheep and beef industries. A genotype by environment interaction is when the genetic rankings of individuals change depending on the environment they are run in. Understanding these effects will help in ensuring that commercial farmers have appropriate information to help them in their ram and bull buying decisions so that they select animals that are appropriate to their farming environments.

   Many of the negative effects of selective breeding are recessive single gene effects which have increased in frequency due to inbreeding. B+LNZ Genetics is not undertaking research into the effects of inbreeding as these are well understood and there are commercial services to help farmers control inbreeding. B+LNZ Genetics has been involved in the development of DNA tests for these single gene conditions. These DNA tests have been very successful in finding animals that carry the condition, but to not express it. The Microphthalmia DNA test is an example of this.

4. What technology does your organisation see as being useful in dealing with breeding issues? What are the most exciting new or emerging breeding technologies for your organisation?

   B+LNZ Genetics is planning a range of technologies to deal with breeding issues. In particular, we are developing selection tools for the sheep and beef breeding industry based on genomic sequence and high density SNP chips (700,000 Single Nucleotide Polymorphisms 'SNPs' that allow a genome wide association study to identify association of specific SNPs with an observed phenotype). These DNA technologies will enable the measurement of genetic merit without the need to, for example, challenge individuals with a disease to measure their resistance to it.

   A genetic evaluation system that is able to analyse both DNA and phenotypic data at the same time is planned as part of the B+LNZ Genetics research programme. This 'single-step' system will ensure that as much information as possible is included in any genetic analysis, meaning the likelihood of unfavourable outcomes is reduced.

   A core part of the B+LNZ Genetics programme is the Central Progeny Test. This is a national evaluation of industry rams (and a beef progeny test is under development). There are five test sites distributed between North and South Island and hill and lowland farm types. Animal performance is being measured in a range of environments to ensure that we do not find rams that rank well on one farm class have poor performance on another farm class.

5. What does your organisation see as the key drivers for the future in terms of selective breeding?

   In the sheep and beef industries, we have observed that there has been a change in scale of many of the breeding operations, with average flock and herd size increasing. The larger flock/herd sizes normally invest

in technology to a greater extent. The advancement of technology allows for the early identification of traits that are of interest to the breeding sector, for traits with either a positive or negative perspective. The current SNP chip technology will allow a breeder to make selection decisions on farm at very early in an animal's life (e.g. an estimate of reproductive performance could be known from a DNA test at weaning rather than having to wait for the animal to reach reproductive age). The closer relationship between industry and the development of technology to assist and facilitate allows for early adoption and mitigation of risk in selective breeding. For example, with Facial Eczema, it was originally a Northern North Island specific disease. However, its prevalence is increasing as the climate changes and cases have been reported in the Northern South Island. With development of genomic selection tools to identify animals resistant to FE, sheep breeders in the South Island are able to select for animals that are increasingly resistant – as opposed to spending 20 years breeding a selection line resistant to the disease.

6. What, if any, lessons from the past have led your organisation to change selective breeding practices within your breed or species?

   Many of the single gene disorders that have appeared in the NZ sheep and beef industries have been because of so called "bottlenecks" in the breeds. For example, sheep breed importations into New Zealand in the 1980s saw entire breeds established from very small populations. In cattle the widespread use of artificial insemination means that some animals can have enormous use in industry. The lessons learnt are that:

   – tools are needed to ensure that genetic diversity is maintained in our populations
   – the same tools are valuable in removing the conditions if they already exist in the population

   New genomic technologies are aiding in both of these areas and hopefully reducing the incidence of these conditions.

New Zealand Thoroughbred Racing

National Animal Welfare Advisory Committee

SELECTIVE BREEDING

Equines

Simon Cooper
4 November 2014

NZTR

Racehorses Through the Ages

17th Century

The Darley Arabian - Based on English painter John Wootton's original painting, this hand-colored lithograph by an unknown artist depicts one of the three English stallions of the 18th century that began the thoroughbred horse lineage. - © AMNH/C. Chesek

18th Century

19th Century

20th Century

NZTR

Equines in New Zealand

- The racehorse was developed in 17th- and 18th-century England, when native mares were crossbred with imported Oriental stallions of Arabian, Barb, and Turkoman breeding

- Horses have always been part of New Zealand's culture. The first horse was introduced with the missionary Samuel Marsden exactly 200 years ago in 1814 (Racing started when the second horse arrived)

- By 1911 there were 404,000 horses in New Zealand, used principally for transport, farming, warfare and, more and more commonly, in sport and racing. Today there are approximately 120,000

- Equestrian sport horses come from a variety of breeds and are trained for the needs of the sport/rider

- Over recent years there has been an increase in the number of horses purpose-bred for sports from imported proven stock with the aim of improving the athletic ability of the local NZ horses

Ethical Approach to Selective Breeding

- The racehorse is bred principally for speed - a form of selective breeding creating animals designed to win horse races

- Sport horses are bred for athleticism - a form of selective breeding creating animals designed to jump fences, perform complicated manoeuvres etc.

- If there is a conformational fault, is the fault likely to be passed to the next generation?

- Does the racehorse travel faster than its skeletal structure can support?

- The inexact science of breeding maintains breeding: “Breeding the best to the best and hoping for the best”

- The best horses go to the breeding shed – the others generally do not

Positive And Negative Effects

Race and sport horses perform with maximum exertion sometimes causing injury :

- EIPH (Exercise Induced Pulmonary Hemorrhage)

Rule 651: 'If a horse suffers more than one attack of nasal bleeding such horse shall be ineligible to start in any race.'

- TB breakdowns resulting in euthanasia in NZ in the last 24 months due to a range of reasons: haemorrhage, fractured shoulder/leg/neck, arythmia etc.

- Selection for race performance only has seen sub-fertile stallions stand at stud to then pass on poor fertility (e.g. Northern Dancer / Valley Victory / Speedy Crown

- This would not happen in other animal production systems where fertility is a mandatory requirement no matter how 'good' the sire *might* be

- There will be biomarkers identified in time to check for this before breeding

Tracks or Training or Medication...or Breeding?

- Massey University quantified the prevalence of horses failing to finish a race, and variables that are significantly associated with horses failing to finish a race including lost rider

- These data have indicated the rate in New Zealand racing is very low by international standards: 89/31,605 starters failed to finish a race with an incidence rate of 2.8 horses/1000 starters and18 horses died on a race day with a fatality incidence rate of 0.57 horses/1000 starters

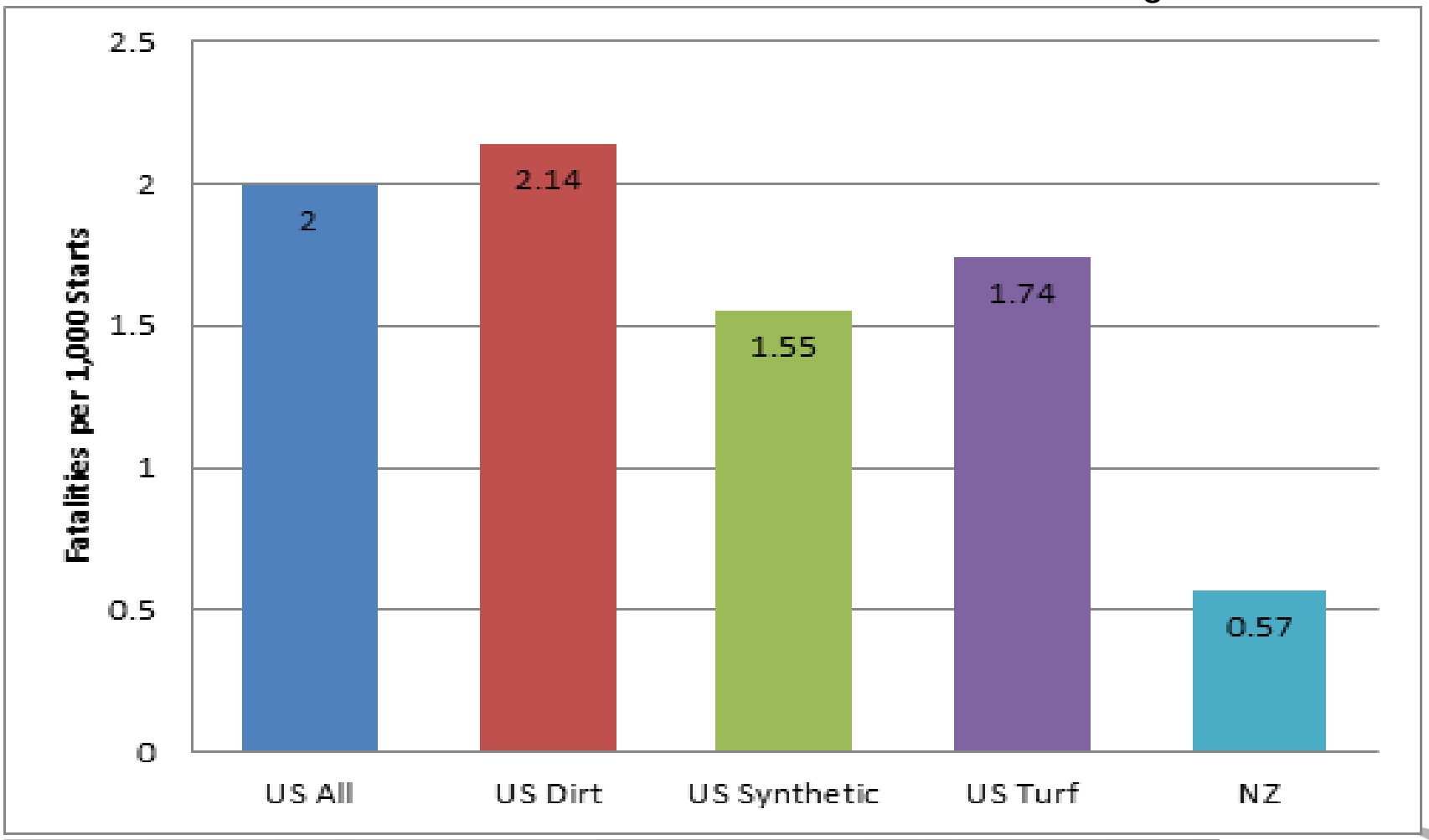
- Data from the USA Jockey Club equine injury database reports a fatality incidence rate four times higher than New Zealand's of 2 horses/1000 starters across all surfaces and 2.14 horses/1000 starters on dirt tracks

- Is this disparity due to Tracks or Training or Medication...or Breeding?

NZTR

US Racehorse Breakdowns vs. NZ

US data of fatalities per 1,000 starts as reported from the USJC Equine Injury Database 1 Nov 2008 to 31 Oct 2010 and NZ data 2010/11 racing season



NZTR

Technology in Dealing with Breeding Issues

- Thoroughbred Rules of Racing 407 (c):
...a horse must be the product of a natural service...and any other form of artificial breeding (including artificial insemination, embryo transfer or transplant, cloning, or any form of Genetic Manipulation at any stage of the horse's existence) may not be used to produce the horse.'

- Standardbreds embrace technology with frozen semen, embryo transfers and Artificial Insemination but there is no sex-sorted semen allowed

- Equine governing bodies and breed associations/societies do not see any welfare issues related to these procedures if they are carried out under normal animal husbandry protocols

- France has identified biomarkers for standardbreds: AA marker means it will run well as a 2YO and 3YO and AC taking longer to mature - no one marker is perfect in predicting the future

- Could 'Breed the best to the best and hope for the best' become ...
'Breed the best biomarkers and hope for the best?'

NZTR

Key Drivers For Thoroughbred Breeding

- Imports have risen over the last 10 years and exports have recently declined. Offshore drivers are not within our control (but domestic incentives are including prize-money, handicapping, programming)
- Number of NZ mares bred is a response (with a lag) to price signals, driven by the health of the domestic industry and to a lesser degree offshore demand
- Thoroughbred starter numbers could decline by 2% each year in the future
- With no change in race numbers, this would require a cut in race numbers from 2,776 to 2,521 in 2020 or we would see a fall in average field size from 10.69 to 9.71 and a comparable decline in wagering turnover
- Fillies and mares racing

Key Drivers For Selective Breeding – The Market

Thoroughbred foal crop returns from the world's eight leading breeding countries from FY04 to FY13 show a global trend

Red – TB foal crop decrease on previous year *Black – TB foal crop increase on previous year*

Country	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13
US	34,798	35,046	34,887	34,301	32,174	29,500	25,800	23,200	22,500	21,275
Australia	16,940	17,178	18,413	18,255	18,388	16,112	17,191	15,893	15,540	13,365
Argentina	6,572	6,783	7,430	7,538	8,264	8,471	8,437	8,761	8,652	8,032
Ireland	10,992	11,748	12,004	12,633	12,419	10,167	7,588	7,550	7,546	7,757
Japan	8,213	7,930	7,632	7,495	7,343	7,453	7,105	7,064	6,819	6,825
France	4,931	5,252	5,373	5,393	5,447	5,524	5,470	4,984	4,823	4,809
GB	6,318	6,003	5,794	6,052	6,043	5,652	4,665	4,635	4,366	4,420
NZ	4,509	4,600	4,561	4,264	4,654	4,469	4,334	4,161	3,899	3,842
TOTAL	**93,273**	**94,540**	**95,797**	**95,931**	**94,732**	**87,348**	**80,590**	**76,248**	**74,145**	**70,325**

NZTR

Key Drivers For Thoroughbred Breeding

Racing Season	Total NZ	Imported	Total Starters	Starts/ Starter	Total Starts	Races	Average Field Size
2005/2006	5,374	268	5,642	5.49	30,981	2,848	10.88
2006/2007	5,282	284	5,566	5.71	31,757	2,863	11.09
2007/2008	5,263	313	5,576	5.81	32,374	2,970	10.90
2008/2009	5,458	368	5,826	5.90	34,348	3,088	11.12
2009/2010	5,379	415	5,794	5.77	33,446	3,068	10.90
2010/2011	5,272	410	5,682	5.74	32,592	3,048	10.69
2011/2012	5,153	457	5,610	5.78	32,425	3,061	10.59
2012/2013	5,047	434	5,481	5.72	31,331	3,007	10.42
2013/2014	4,933	406	5,340	5.70	30,437	2,870	10.61
2014/2015	4,809	396	5,205	5.70	29,671	2,776	10.69
2015/2016	4,699	387	5,086	5.70	28,989	2,776	10.44
2016/2017	4,604	379	4,984	5.70	28,407	2,776	10.23
2017/2018	4,520	372	4,893	5.70	27,889	2,776	10.05
2018/2019	4,442	366	4,808	5.70	27,406	2,776	9.87
2019/2020	4,367	360	4,727	5.70	26,945	2,776	9.71
CAGR			(2.01%)		(2.01%)		(1.47%)

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2015/2016	4,699	387	5,086	5.70	28,989	2,712	10.69
2016/2017	4,604	379	4,984	5.70	28,407	2,658	10.69
2017/2018	4,520	372	4,893	5.70	27,889	2,609	10.69
2018/2019	4,442	366	4,808	5.70	27,406	2,564	10.69
2019/2020	4,367	360	4,727	5.70	26,945	2,521	10.69
CAGR							(2.14%)

NZTR

Lessons / Conclusions

- Governing bodies of equine breeds have no direct control over the breeding of the horses that are involved in the disciplines they administer

- Successful breeders breed successful horses... or successful horses make successful breeders

- Breeding procedures are carried out under normal animal husbandry protocols and overseen by the Veterinary profession

- The key drivers for the future direction of breeding will be the market that will require successful competitive horse

NZTR

Last Word

'...any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form'